THC-1

Torch Height Control

Instruction Manual
800180 – Revision 1

Hypertherm®
The world leader in
plasma cutting technology

INSTRUCTION MANUAL
IM-18 (C1)

THC-1

TORCH HEIGHT CONTROL

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SECTION 1 INTRODUCTION

The Hypertherm THC-1 is designed to accurately and reliably control torch height for the Hypertherm PAC-500 Plasma Arc Cutting System. The THC-1 performs its task by operating in two distinct modes: Initial Height Sensing (IHS), and Automatic Voltage Control (AVC). It also provides a means for interfacing the plasma arc cutting system with the N/C controllers provided on many shape contouring machines.

The Initial Height Sensing mode sets the correct torch height above the workpiece prior to making a pierce start. Ideally, the position of the workpiece should be sensed directly under the torch. Errors due to holes previously cut in the workpiece, or to the proximity of the workpiece edge are thus avoided. The Initial Height Sensing System (Fluidic Type) meets this requirement by using the plasma torch itself as a detecting device. This exclusive Hypertherm technique operates by sensing a slight change in nozzle bore pressure as the torch approaches the workpiece with the arc gas flowing. When the work is detected, the torch then retracts to the correct piercing height using the point of detection as a reference height. This technique is designed for use with the Hypertherm .120, .166, and .187 nozzles. It may therefore be used when cutting materials up to two inches (50mm) in thickness and provides a very reliable and accurate means of initiating a cut by automatic methods.

When using the plasma system for underwater cutting, the above technique cannot be used. The sensing method would prevent the torch from proceeding below the water level because the water itself would be sensed as a solid object. In underwater applications, this problem is overcome by use of an inductive probe assembly which works in a similar manner (electronically) to the fluidic technique. This method may be used for cutting applications both above and below water. A retrofit kit described as Underwater Cutting Option, Stock No. 028162 is available for converting existing THC-1 units to underwater use. Contact Hypertherm for further ordering information if this feature is desired on a new unit.

Upon completion of the IHS sequence, the THC-1 sends a start command to the plasma arc cutting control console. After arc ignition is obtained, the Automatic Voltage Control (AVC) commences. AVC works by comparing the actual arc voltage to a reference voltage set by the operator (or by the N/C controller on programmable versions.) The THC-1 then activates the torch suspension motor to move the torch up or down as required to match the arc length (arc voltage) to the reference voltage. This technique is highly accurate and reliable having the capacity to control torch height within ±.025 inches (0.635mm). This description, however,is deceptively simple, because it is necessary to provide complex signal processing logic to prevent the height control from reacting inappropriately to irregularities in the arc voltage signal caused by such common events as crossing a previous cut or intentionally running off the edge of the workpiece. The Hypertherm THC-1 design incorporates the necessary signal processing features and has a long established reputation for performing flawlessly in conditions unsuitable for competitive units.

TYPES OF THC-1 UNITS AVAILABLE:

Three versions of the THC-1 are available. All three versions permit N/C control of the cutting sequence.

1. Standard Unit: Includes all switches on the front panel of the THC-1 Control Module. Reference voltage must be set manually by the operator.

2. Programmable Voltage + Remote Switch version:
   Switches are provided by the contouring machine manufacturer on the machine control panel. Voltage may be set by the N/C controller or manually by the operator at the THC-1 Control Module.

3. Remote Switch version (non-programmable).
   Switches are provided by the contouring machine manufacturer on the machine control panel. Reference voltage is set manually by the operator at the THC-1 Control Module.

COMPONENTS INCLUDED IN THE THC-1 PACKAGES

Pkg. Stock No.	Description	Component Stock No.
050001	THC-1 (Standard Version)	
	Control Module	053001
	IHS Module - Fluidic	053013
	Voltage Divider	041007
	IHS Hose, 30" (762mm)	024088
	Clamp	008010
	Plug - 14M (MS 3106B 20-27P)	008086
050002	THC-1 (Prog.Volt.& RemoteSwitch)	
	Control Module	053003
	IHS Module - Fluidic	053013
	Voltage Divider	041007
	IHS Hose, 30" (762mm)	024088
	Clamp	008034
	Plug - 20M (MS 3106B 28-16P)	008033
050003	THC-1 (RemoteSwitch)	
	Control Module	053004
	IHS Module - Fluidic	053013
	Voltage Divider	041007
	IHS Hose, 30" (762mm)	024088
	Clamp	008034
	Plug - 20M (MS 3106B 28-16P)	008033
	OPTIONAL:	
028162	Underwater Cutting Option	
	Inductive Probe Asssembly	029044
	IHS Module - Inductive	053012

NOTE: THC-1 units are supplied with torch lifter motor control relays for use with A.C. motors. Relays for D.C. motors are available upon request. The motor control relays, 4 CRE and 5 CRE, are RED if for use with A.C. motors, BLUE if for D.C. motors.

The torch lifter motor is normally provided by the contouring machine manufacturer as part of the torch station.

SECTION 2 SAFETY

Installation or repair work on the THC-1 unit, as well as the other components of the plasma arc cutting system, should be performed only by those qualified to handle high voltages and high pressure liquid and gas lines. While most of the THC-1 logic circuitry operates at only 15 VDC, The signal input at the voltage divider is 400 VDC and input to the board power supplies is 120 VAC. Contact with these voltage sources could result in fatal electric shock. Gas and water pressures over 150 psig. are also present and should be respected as potential sources of injury if improperly handled. Prior to operation of any plasma arc cutting equipment, it is important to ascertain that all exposed personnel are protected from fumes, noise and ultraviolet radiation as recommended in the plasma cutting system instruction manual.

SECTION 3 SPECIFICATIONS

MODEL THC-1 TORCH HEIGHT CONTROL

Control Module

Stock Number.....(all models)
Power Input..... 120 VAC. 50/60 Hz, 50VA
Dimensions..... 6 in. High x 8 in. Wide x 18 in. Deep
(152mm x 203mm x 457mm)
[allow additional 8 inches (203mm) in longest dimension for cable end connectors]
Weight..... 15 Lb. (6.8 kg)
Arc Voltage Setting Range..... 100-250 VDC
Control Accuracy..... ±2 volts
(equiv.to approximately ±0.025 inches [0.635mm] of arc length)
Environmental Tolerance..... 0-50°C

Fluidic Initial Height Sensing Module

Stock Number..... 053013
Input power..... 120 VAC from THC-1 Control Module
Pressure..... 150 psig. Maximum
Dimensions..... 4½ in. High, 9 in. Wide, 11½ in. Deep
(Including fittings..... 13½ in. Deep)
(114mm x 229mm x 292mm)
(Including fittings..... 343mm Deep)
Weight..... 10 Lb (4.5 kg)

Inductive Initial Height Sensor

Underwater Cutting Option (Stock No. 028162) includes Inductive Initial Height Sensor Module (Stock No. 053012) and Inductive Probe Assembly w/10ft. hose & cables (Stock No. 029044)

Inductive IHS Module:
Input Power..... 120 VAC from THC-1 Control Module
Air Pressure into solenoid valve.. 20 psig regulated shop air
Dimensions..... 4½ in. High, 9 in. Wide, 11½ in. Deep
(Including fittings..... 13½ in. Deep)
(114mm x 229mm x 292mm)
(Including fittings..... 343mm Deep)
Weight..... 13 Lb (6 kg)

Inductive Probe Assembly:
Power and Signal Input/Output... From/To Inductive IHS Module
Pressure into air cylinder-from Inductive IHS Module (20psig)
Cylinder Stroke..... 6 inches (152mm)
Torch Mounting Bracket Shaft Diameter..... 5/8 in. (16mm)
Overall Assembly Clearance Dimensions
(incl. cylinder air fitting)
Probes retracted... 20 in. High x 6½ in. Wide x 8 in. Deep
Probes extended.... 26 in. High x 6½ in. Wide x 8 in. Deep
Probes retracted..... (508mm x 165mm x 203mm)
Probes extended..... (660mm x 165mm x 203mm)
Note: Clearance depth of 8 inches (203mm) includes Water Muffler and its hose fitting.
Weight (Probe Assy Only)..... 6 Lb (2.7 kg)

SECTION 4 PREINSTALLATION REQUIREMENTS

To make full use of the features of the THC-1, sufficient switching functions must be provided in either the N/C software or hardware. These requirements are described below.

MACHINE TRAVEL DELAY:
A means for delaying the start of machine travel for a short duration after arc ignition must be provided. In most cases, this may be done easily with proper N/C software. This function may also be provided in hardware (ie: an adjustable time delay relay), although such an arrangement will require the operator to control one additional function.

The amount of delay time required fits a general rule of one second of delay for each inch (25mm) of workpiece thickness. The delay gives the arc time to penetrate through the workpiece prior to the start of machine movement. In actual practice, the delay period required for material less than $\frac{1}{2}$ inch (12mm) thick is insignificant and may be omitted. However, it is essential to provide the proper delay time on greater thicknesses.

CORNER SLOW-DOWN and THC-1 CORNER LOCK-OUT:
The N/C Controller should be capable of slowing machine travel speed down while processing small radius corners. This function will reduce the lag angle of the arc, thus insuring square cuts on the corners. Such speed changes can ordinarily be programmed into the N/C software with no difficulty. However, it is also necessary to mark these slow speed events with a contact closure to the THC-1 so that the automatic height control (AVC) can be disabled during the completion of the corner. The N/C controller must therefore have the necessary switching capacity to mark these events.

SWITCHING CONTACTS REQUIRED:

Upper Limit Switch:
A limit switch must be provided on the torch lifter mechanism. This switch should be Normally Closed, opening when the torch reaches the fully raised position.

N/C Controller Activated Switches:

The Standard THC-1 Module requires three N/C Controller activated switches for the START, STOP, and CORNER functions.

The Remote Switch THC-1 Module requires the above three N/C activated switches, and, in addition, requires two switches for the CONTROL and ARC mode selections. While these two may be manually operated switches provided on the machine control panel, some machine manufacturers provide them within the N/C controller.

Remote Switch-Programmable Voltage THC-1 Modules require the five switches mentioned above, plus eight additional switches for the programmed voltage feature.

These switches may be mechanical relays, D.C. solid state relays, or transistors. Mechanical relays offer the best isolation between the N/C controller and the plasma arc system. D.C. solid state relays of either the opto-isolated or transformer coupled type also offer ground isolation. If ground isolation is deemed unnecessary, transistors may be used.

Mechanical relays with precious metal or welded contacts are preferred. D.C. solid state relays must have a low leakage specification of 100 microamperes or less. Both relays and transistors must be able to handle 8 milliamperes per input at 15 volts.

Transistors should be of the NPN, open collector type. They may be discrete, or in high voltage integrated circuit buffers such as the Texas Instruments SN75462 (30 volts, 300 ma.)

Further switch specifications may be determined from their actual functions as described below.

SWITCH FUNCTIONS:

Function	Logic Input Required and Description of Function
STOP	Normally open. Momentary contact closure to logic ground initiates plasma stop. (approx 100 ms req'd)
START	Normally open. Momentary contact closure to logic ground initiates start function. (approx 100 ms req'd)
CONTROL	Contact closure maintained to logic ground selects automatic mode (enables IHS and AVC functions). If this contact remains open (manual mode), the IHS function will be bypassed and the plasma system will operate without benefit of the automatic height control (AVC). Closure may be made after arc initiation which facilitates manual pierce height setting on heavy plate while still permitting automatic height control.
ARC	Contact closure maintained to logic ground selects automatic mode (arc start enable). If this contact remains open (manual mode), the THC-1 will proceed to the IHS Complete state and hold in that state. Occasionally, the operator may wish to use this hold state to verify proper torch position before permitting arc initiation. If he is satisfied with the torch position, he causes contact closure and plasma start begins.
UPPER LIMIT SWITCH	Located on the torch lifter, this switch is normally closed. It must open when the torch reaches the fully raised position.

HOLD — The hold function synchronizes the plasma start sequence of all THC-1 units in multi-torch installations. It does not require a switch. However, it is convenient to provide a spare terminal at the Controller for hold connections. All hold terminals must be connected to this common point.

The hold terminal for each THC-1 Control Module is at logic state 0 until that module completes the IHS function, at which time it switches to logic 1. All modules must be at logic 1 before any module can proceed to plasma start. If a THC-1 Module is turned off, it will have no influence on other modules. The operator may therefore turn any module off if he does not wish to use its torch for the job at hand

CORNER — Normally open. Contact closure maintained to logic ground selects corner function (Disables AVC.). This feature prevents the torch from diving into the workpiece during cornering due to the abnormally low arc voltage produced by slowing the travel speed.

LOGIC GROUND — The logic ground connections of all THC-1 Control Modules must be connected together. This terminal point is also the other pole of the switches required above. Note, however, that each Control Module requires its own set of switch contacts. Do not attempt to operate identical functions of different modules with only one switch contact.

ADDITIONAL SWITCH REQUIREMENTS FOR PROGRAMMED VOLTAGE FEATURE

The input connections for programming the voltage setting consist of one Common Line (Logic Ground) and seven Voltage Select Lines. A voltage value is selected by connecting the appropriate Voltage Select Lines to the Common Line (Logic Ground).

In addition, it is necessary to select the Programmed Voltage Function by connecting the Programmed Voltage Select Line to Logic Ground. Eight N/C controlled switches are required to permit selection of all combinations. The protocol for the programmed voltage function is further described on page 17.

SECTION 5 INSTALLATION

UNPACKING AND INCOMING INSPECTION

Calibration, extensive testing, and careful inspection are performed on the THC-1 components prior to shipment. All units are shipped in verified operating condition. Carefully inspect each unit for posssible damage sustained in shipment. If damage is found, notify the carrier and Hypertherm immediately. It is important to retain the shipping container and the packing material for examination by the carrier in order to place a claim for shipping damages. If return of any components to Hypertherm is required, refer to Section 7, page 22, "Return Shipments".

PHYSICAL LOCATION OF COMPONENTS

Control Module

The THC-1 Control Module(s) should be installed at a position where the operator has ready access to the voltage setting thumbwheel and the function switches. In multiple torch installations, the Modules may be stacked to facilitate the operator's access to all units.

Even remote switch/programmable voltage units should be located in this manner so that the operator can view the status lights on the modules. This will enable him to identify command blockages and quickly determine the cause of any problems.

Refer to Figure 7, page 37 for Control Module mounting dimensions. Note that only three pre-tapped (8-32) holes are to be used in mounting this unit.

Voltage Divider

The Voltage Divider, Figure 5, page 35, Should be installed in the PAC-500 Plasma Console. It should be placed on the floor of the console on the side where the Cathode Block is located. See Figure 8, page 38 for the proper location.

IHS Module

Either Fluidic or Inductive IHS Modules should be mounted near the plasma console for convenient hookup. This is especially true of the Fluidic Type module because it includes a hose of 30 inch (762mm) length which must be connected to the torch connection side of the plasma console. Be sure to check that this connection can be made before fastening down the IHS module. Refer to Figure 9, page 39 for the correct mounting dimensions.

Inductive Probe Assembly

The Inductive Probe Assembly includes a Torch Mounting Bracket. The bracket (and entire assembly) should be installed on the torch station of the contouring machine. The bracket mounting shaft is 5/8 inch in diameter (16mm). The plasma torch may then be installed in the bracket. Initially, the torch should be installed as high as possible in the torch bracket without making contact between the stainless steel torch body and the bracket. Final adjustment of torch position is described in the Initial Checkout Procedure at the end of this section (page 11 , step 20).

ELECTRICAL HOOKUP

Six wires and/or cables are required to interconnect the THC-1 components and the shape contouring machine. The necessary connections are indicated in Figures 16 and 17, pages 46 and 47. Be sure to select the Figure that corresponds to the Control Module being installed. Compare the console stock number with the stock number shown on the drawing.

These cables are listed below along with a recommendation for the type cable or conductor size to be used.

CABLE OR WIRE NAME	RECOMMENDED TYPE	DESCRIPTION OF TYPE
Cntrl Module to Torch Lifter Motor	Belden 8465FR	18 AWG. 5 Conductors
Control Module to N/C Controller	Belden 8778FR	22 AWG., Six Pairs
Control Module to IHS Module	Belden 8778FR	22 AWG., Six Pairs
IHS Module to Plasma Console	Belden 8778FR	22 AWG., Six Pairs
Voltage Divider to Star Ground	Stranded Copper Wire, 18 AWG.	
Control Module to Star Ground	Stranded Copper Wire, 18 AWG.	

AWG. is American Wire Guage (diameter).
18 AWG.= 0.040in. (1.016mm)
22 AWG.= 0.025in. (0.635mm.)

Belden Type 8778FR cable has six pairs of conductors. Each pair has a shield wire for grounding purposes and a metalic foil wrap around each pair and its ground wire.

GROUNDING

The THC-1 is a high gain electrical sensing device and requires specific grounding procedures to avoid response of the device to stray electrical noise. Note that the Voltage Divider Ground Terminal and the Control Module Ground Stud (on rear panel) MUST be connected directly to a point, referred to as the Star Ground, on the Water Table. Reliance on other grounding points invariably leads to erratic operation due to pick up of stray voltages or to loss of signal through wheel bearings and such.

Initial Height Sensing Module

Refer to Figure 15, page 45 for connections to the Fluidic Type IHS Module (Stock No.053013). Connections for the optional Inductive IHS Module (Stock Number 053012) are shown on page A2 in the Appendix. This figure also shows the proper connections for the Inductive Probe Assembly.

INITIAL SYSTEM CHECKOUT

After all wiring has been completed, the system may be checked for proper operation as follows:

1. Insert the following parts into the plasma torch.
   a. Electrode Stock No. 020038
   b. Swirl Ring Stock No. 020039
   c. Nozzle .166 Stock No. 020035

2. Place a piece of scrap metal plate under the torch to be used for test cuts. It should be $\frac{1}{4}$ to $\frac{1}{2}$ inch (6mm to 13mm) thick.

3. Place plasma TEST/RUN Switch in TEST position.

4. Turn on gas supply and adjust to 150 psig. (10.3 bar)

5. Turn plasma power supply ON.

6. Turn Chiller Pump or Water Supply Pump ON.

7. Adjust water supply pressure to 185 psig. (12.8 bar).

8. Place THC-1 Power Switch ON.

9. Place THC-1 Control Switch in MAN position.

10. Place THC-1 Arc Switch in AUTO position.

11. Operate Manual UP/DOWN Switch to verify movement of torch in proper direction.

    VERIFY THAT NO PERSONNEL ARE IN THE VICINITY OF THE PLASMA TORCH OR IN THE PATH OF MACHINE MOVEMENT.

12. Depress START Switch.
    Gas and water should now be flowing out of the torch.
    adjust the gas flowmeter to a setting of 45% of scale and the water flowmeter to a setting of 75% of scale.

    Because the TEST/RUN Switch is in TEST position, no arc will strike.

13. If THC-1 unit is equipped with Underwater Cutting Option, skip to step 14. If equipped with standard Fluidic IHS, continue this step.

    With the gas and water continuing to flow, loosen the hose fitting at the IHS module and allow water to flow until all air is expelled from the hose; then retighten fitting.

14. Depress the STOP Switch to terminate the TEST sequence.

15. Place THC-1 Control Switch in AUTO position.
    The torch should now retract to the full up position.
    (unless it is already in that position.)
16. Place THC-1 Arc Switch in MAN position.

17. If the THC-1 unit is equipped with the Underwater Cutting Option, adjust the gas pressure to the probe assembly air cylinder to 20 psig. (1.4 bar).

18. Depress the START switch.

    If the standard Fluidic IHS is used, Gas will now flow from the torch. Water will not spray from the torch except for the small residual amount remaining in the nozzle. If the Underwater Cutting Option is used, the air cylinder will extend the two inductive probes downward. With either system, after a four second delay, the torch will begin to move downward.

19. The torch should stop approximately 3/8 of an inch (10mm) above the workpiece. The THC-1 will now remain in the IHS Complete state as indicated by the LED indicator on the THC-1 Control Module. At this time, if the Underwater Cutting Option is in use, the torch should be adjusted in its bracket to provide a standoff (torch to work distance) of 3/8 inch (10mm).

    If the torch strikes the workpiece, depress the STOP Switch. This will cause the torch to retract to the full up position. Refer to Section 7, Troubleshooting, page 18 to remedy this problem.

20. Set machine travel speed or feed rate at 100 ipm (2540 mm/min).

21. Set the voltage thumbwheel switch, on THC-1 Control Module, to 155 volts or program the N/C Controller to set 155 volts. (See page 17)

22. Set the power supply for an output of 400 amperes.
    This will be a dial setting of approximately 60 on an H-401 power supply or 35 on an H-601 power supply. A final adjustment of arc current may be made after arc ignition.

--- CAUTION ---

Before proceeding, you must be familiar with the operation and safety requirements described in the plasma arc cutting system instruction manual (IM25, IM-37, or IM-46). Do not proceed until all safety requirements have been met.

24. Place the TEST/RUN Switch in the RUN position.

    VERIFY THAT NO PERSONNEL ARE IN THE VICINITY OF THE PLASMA TORCH OR IN THE PATH OF MACHINE MOVEMENT.

25. Place the ARC Switch in the AUTO position.
    Gas and water will begin to flow from the torch and after 5 seconds, the arc will strike.

26. Observe the LED indicators on the THC-1 Control Module. One half second after arc ignition, the AVC-ON LED should light. The UP/ DOWN LED indicators will flash as variations in workpiece elevation are encountered.

    Stop the cutting operation by depressing the STOP Switch, or by allowing the torch to run off the edge of the workpiece.

    The THC-1 System is now ready for routine use if proper operation has been obtained.

SECTION 6 OPERATING PROCEDURES

SEQUENCE OF OPERATION: Prior to starting a cut, the operator must place an electrode and the proper swirl ring and nozzle into the torch as determined from the Operating Data Tables, pages 24 to 29. He should then set the following parameters:

Gas Flow Rate
Injection Water Flow Rate
Arc Current
Arc Voltage
Machine Travel Speed/Feed Rate
Travel Delay Time [1 second/inch (25mm) of workpiece thickness]

Some or all of the last four parameters may be programmed into the N/C software depending upon system configuration.

The cutting sequence is begun by a start command from the N/C Controller or by the operator depressing the START toggle switch. This signal begins the Initial Height Sensing (IHS) sequence. Gas begins flowing from the torch and, after a four second delay, the torch moves downward toward the workpiece. When the torch approaches within about $\frac{1}{4}$ inch (6mm) of the workpiece, it detects an increase in the gas pressure within the nozzle, stops the downward movement, and retracts the torch to a height of about 3/8 inch (10mm). The IHS Complete LED indicator lights at this time, and a start signal is automatically transmitted to the plasma console. In multiple torch installations, this start signal will be inhibited by the HOLD function until all THC-1 units have completed the IHS sequence.

Torch ignition occurs five seconds after the IHS Complete state has occurred. The plasma console includes a multiple torch ignition synchronizing circuit which causes all torches to receive a high frequency starting pulse simultaneously. Arc ignition generates an ARC-ON signal from the plasma console which is used to initiate machine movement and Arc Voltage Control (AVC). AVC is accomplished in the THC-1 Control Module which causes the torch lifter motor to adjust torch height up or down. The resulting adjustment of arc length matches the arc voltage to the reference voltage preset on the THC-1 Voltage Thumbwheel Switch or N/C programmed reference voltage. The AVC function begins $\frac{1}{2}$ second after the ARC-ON signal is received. This delay permits establishment of a stable arc before automatic adjustment of torch height begins.

The cutting operation is terminated by a stop command when the operator depresses the STOP toggle switch or by a similar stop signal generated by the N/C Controller. If no stop command is generated, the plasma system will stop when there is no material remaining under the torch such as at the edge of a workpiece. Each time the arc is extinguished, the THC-1 automatically raises the torch to the full-up position to facilitate rapid traverse to the next piercing position without danger of torch collision with up-ended cut parts.

SPECIAL PERFORMANCE FEATURES OF THE THC-1:
The THC-1 is capable of maintaining the torch height within ±.025 inch (0.635mm). Such performance requires a high degree of sophistication in the design of logic circuits used to process the raw arc voltage signal. The high level of electrical noise in the arc must be eliminated and the height control unit must not react to common disturbances in arc voltage such as caused by crossing previous cuts. In addition, it is necessary to prevent the torch from diving into the work as a result of arc voltage changes encountered when cutting through to the edge of the workpiece or when slowing travel speed during cornering.

The THC-1 avoids these difficulties with appropriate logic circuits to discriminate between voltage changes due to workpiece elevation variations and voltage excursions due to momentary changes in the cutting operation. The CORNER function disables the AVC operation when corners are being cut at slower speeds. The slow speeds result in an increase in arc voltage which would cause the torch to dive into the workpiece if height adjustments were not inhibited. Operation of the CORNER function requires that a contact closure, provided by the N/C Controller, be maintained to the THC-1 for the duration of each corner cutting operation.

It is worth stating again, the importance of using the proper grounding procedures as mentioned on page 9. Improper response of the THC-1 unit is almost invariably related to incorrect ground connections.

Switch Functions: Under ordinary circumstances the THC-1 should be used with the CONTROL Switch and the ARC Switch in AUTO position. This will enable use of all THC-1 functions as described above.

Some circumstances will make it desirable to defeat the IHS, AVC, or the Automatic Plasma Start functions to accomplish the task at hand. To understand the uses of the switches, their functions are described below.

POWER: This switch turns 120 VAC power ON or OFF to the THC-1 Control Module. In multi-torch installations, this switch may be used to prevent operation of a particular torch, when desired, while still operating other torches.

CONTROL:
This switch has an AUTO (automatic) and a MAN (manual) position.

In the AUTO position, a start command from either the N/C Controller or the START toggle switch will initiate the IHS function. It will also enable the AVC function to operate after plasma ignition and allow automatic torch retract after the arc is extinguished.

In the MAN position, both the IHS and AVC functions are defeated as is the torch retract function. A start signal from either the N/C Controller or the START toggle switch will cause the plasma console to begin its start sequence without going through the IHS step. After ARC ignition, AVC will not operate.

MAN UP/DOWN:
This spring loaded switch enables manual adjustment of torch height. It should only be used when the CONTROL Switch is in the MAN position. Its function is to allow manual adjustment of piercing height, or height while cutting, if the automatic IHS and AVC functions are not desired.

ARC:
This switch has an AUTO (automatic) and a MAN (manual) position.

In the AUTO position, the plasma start sequence will occur after completion of IHS, if the CONTROL switch is also in AUTO position, or immediately following the operator or controller generated start signal, if the CONTROL switch is in the MAN position.

In the MAN position, starting of the plasma system is inhibited by any means. (Unless a separate start circuit has been connected directly to the plasma console.)

START:
This spring loaded switch permits manual signalling to the THC-1 to start its operation. Depressing this switch will initiate the IHS function or the plasma start sequence depending upon the positions of the other switches.

STOP:
Depression of this spring loaded switch will cause termination of all THC-1 and plasma system functions and if the CONTROL Switch is in AUTO position, will cause the torch to retract. The switch is effective during all system sequences, ie: during IHS and while the plasma arc is on.

USE OF SWITCHES TO MODIFY THC-1 OPERATION:

Heavy Plate:
On some applications, it may be desirable to eliminate or delay the IHS, AVC, or Plasma Start functions. Most commonly this will be when cutting heavy plate over two inches (50mm) thick. Piercing of this thickness is not recommended. It is therefore desirable to manually set the torch height for starting at the edge of the workpiece. This may be done by placing the CONTROL Switch in the MAN position and using the MAN UP/DOWN switch to set torch height.

In the above situation, AVC will not operate. However, after the plasma arc is initiated, the CONTROL Switch may be reset to the AUTO position to obtain AVC. Also note that when cutting at the slow speeds required for plate over two inches (50mm) thick, the THC-1 may not be able to discriminate between previous cuts and changes in workpiece elevation, so it will be necessary to place the CONTROL Switch in MAN position while crossing a previous cut to prevent the torch from diving into the work.

Note: If plate between 1 and 2 inches (25mm - 50mm) thick is frequently cut, it may be desirable to permanently increase the pierce height obtained with the IHS sequence. Refer to Section 7, page 19, to see how this may be accomplished.

Delayed Arc Start:
Occasionally it is desireable to delay the plasma starting sequence until the torch piercing point can be observed for correct positioning. This may be done easily by placing the ARC Switch in MAN position. The IHS sequence may then be allowed to proceed and the THC-1 will remain in the IHS Complete state without starting the plasma system until the operator resets the ARC Switch to AUTO position.

Elimination of Torch Retract Function:
Sometimes when many small pieces are to be cut in a small area, it is desirable to eliminate torch retract and IHS to save time. This may be done by switching the CONTROL Switch to MAN position during the first cut. This will set the torch at the precise height required and keep it there until the CONTROL switch is returned to the AUTO position. However, it should be remembered that AVC will not be operating with the switch in the MAN position, so if their are any variations in workpiece height, torch standoff distance will not be automatically adjusted. For this reason, this mode of operation should be limited to operations confined to a small area. It may be convenient to turn the CONTROL Switch to AUTO position for just a few seconds, while the arc is on, after a few cuts, in order to automatically readjust for variations in plate elevation.

Cutting with Large Nozzles:
When the .220 or .250 nozzles are in use, the IHS function should not be used. These nozzles do not provide reliable IHS operation and in most cases, they are used for materials of greater than two inches thick for which piercing is not recommended. The AVC function will work with all nozzles, however, and may be used by resetting the CONTROL Switch in AUTO after arc ignition, keeping in mind that on thick materials, AVC should be turned off when crossing previous cuts.

PROTOCOL FOR PROGRAMMED VOLTAGE FUNCTION

When the programmed voltage feature is used, a voltage value is selected by connecting the appropriate Voltage Select Lines to the Common Line (Logic Ground) by means of switches (relays, transistors, etc.) in the N/C Controller. Note that a line called Program Voltage must also be connected to Logic Ground to enable this function. (See Figure 17, page 47) Do not connect the Logic Ground Line to earth or Controller chassis ground. It is already connected to chassis ground in the THC-1 Control Module. Additional grounds may create ground loops.

The Voltage Select Lines are divided into three decades (Hundreds Decade, Tens Decade, and Ones Decade). Binary Coded Decimal (BCD) format is used with two (Hundreds Decade) lines called 200 and 100, four (Tens Decade) lines called 80, 40, 20, and 10, and one (Ones Decade) line called 5.

To set a voltage value, select those lines which, when numerically added, sum to the desired value; eg: 145 volts = 100 + 40 + 5. Lines 100, 40, and 5 are all connected to Logic Ground. The Program Voltage Line must also be connected to Logic Ground.

Illegal Codes: Do not select the combinations (80 + 40 + 20), (80 + 40) or (80 + 20). These are illegal BCD codes. These combinations may be avoided by selecting the 100 Line and an appropriate Decade Line. Also do not select codes for voltages above the maximum of 250 volts or below the minimum of 100 volts. A list of all possible legal codes is given below:

VOLTAGE SELECT CODES

1 = select
0 = not select

VOLTAGE	HUNDREDS DECADE		TENS DECADE				ONES DECADE	PROGRAMMED VOLTAGE SELECT LINE
	200	100	80	40	20	10	5	
100	0	1	0	0	0	0	0	1
105	0	1	0	0	0	0	1	1
110	0	1	0	0	0	1	0	1
115	0	1	0	0	0	1	1	1
120	0	1	0	0	1	0	0	1
125	0	1	0	0	1	0	1	1
130	0	1	0	0	1	1	0	1
135	0	1	0	0	1	1	1	1
140	0	1	0	1	0	0	0	1
145	0	1	0	1	0	0	1	1
150	0	1	0	1	0	1	0	1
155	0	1	0	1	0	1	1	1
160	0	1	0	1	1	0	0	1
165	0	1	0	1	1	0	1	1
170	0	1	0	1	1	1	0	1
175	0	1	0	1	1	1	1	1
180	0	1	1	0	0	0	0	1
185	0	1	1	0	0	0	1	1
190	0	1	1	0	0	1	0	1
195	0	1	1	0	0	1	1	1
200	1	0	0	0	0	0	0	1
205	1	0	0	0	0	0	1	1
210	1	0	0	0	0	1	0	1
215	1	0	0	0	0	1	1	1
220	1	0	0	0	1	0	0	1
225	1	0	0	0	1	0	1	1
230	1	0	0	0	1	1	0	1
235	1	0	0	0	1	1	1	1
240	1	0	0	1	0	0	0	1
245	1	0	0	1	0	0	1	1
250	1	0	0	1	0	1	0	1

SECTION 7 TROUBLESHOOTING

The THC-1 unit is tested under extreme operating conditions and is carefully inspected before shipment. Every unit leaves the factory in good operating condition. If difficulties are encountered upon installation, wiring errors should be the first place to look for the cause of difficulty. Other causes are of course possible. The common causes of difficulty are listed below for use if checks on wiring do not locate the cause.

INITIAL HEIGHT SENSOR (IHS) MALFUNCTIONS:

A. TORCH DOES NOT MOVE DOWNWARD TO PIERCING POSITION. READY LED INDICATOR DOES NOT LIGHT.

1. Upper limit switch on torch lifter is misadjusted or malfunctioning. It should be normally closed and should open when torch reaches full up position.

B. TORCH MOVES DOWNWARD AND STRIKES WORKPIECE
(The following eight points apply to the Fluidic IHS Only.)

1. Insufficient nitrogen pressure at plasma console. Pressure must be 150psig. (10.3 bar) while gas is flowing.

2. Dirty or damaged swirl ring or nozzle. Excessive O-ring grease in nozzle or swirl ring openings. (Never use a cracked swirl ring as it may interfere with IHS operation, and could result in irreparable arc damage to torch.)

3. Air entrapped in IHS hose. Remove air by operating plasma system in TEST mode (injection water flowing) with the fitting loosened at the IHS Module. When all air is expelled, tighten fitting. Note: Loose fittings or damaged hose may allow air into IHS hose.

4. Do not use IHS feature when using .220 or .250 nozzles. These nozzles do not produce reliable IHS performance.

5. Make certain proper swirl ring is in use. Only swirl ring stock numbers 020039 or 020042 (ccw) should be used.

6. No power to IHS Module circuit board. Check LED D4 on the board. It should remain lighted during the IHS sequence. If it does not, check relays 1 CR in the IHS Module and 1CRE in the THC-1 Control Module for proper operation.

7. Faulty Pressure Transducer. Turn the THC-1 power off and replace transducer. Note: The transducer and guage protector should be handled as one unit and NOT disassembled. It is filled with oil at the factory using special procedures. Field disassembly will cause it to be inoperable.

8. Faulty IHS circuit board. If the above steps do not correct the problem, replace the IHS circuit board.

C. INSUFFICIENT PIERCE HEIGHT.

The THC-1 is factory adjusted to provide a piercing height of approximately 3/8 inch (10mm). This height should be sufficient for piercing operations on plate up through 1 inch (25mm) thick. Piercing of thicker plate may require increased pierce height. If such operations are only done occasionally, increased height may be obtained with manual operation of the THC-1 (See page 16).

If heavy plate is cut on a frequent basis, the pierce height may be adjusted to a higher setting. This adjustment is made by increasing the retract time following the sensing of plate position. Potentiometer R8 located on the Digital Circuit Board in the THC-1 Control Module controls the retract time. To obtain a higher pierce height, increase the time interval. This must be done on a trial and error basis making only small adjustments to R8. Refer to Figure 18, page 48 to identity the R8 potentiometer and to determine the correct direction of adjustment.

ARC VOLTAGE CONTROL MALFUNCTIONS

A. TORCH DIVES INTO WORKPIECE DURING CUTTING OR TORCH HEIGHT DRIFTS ERRATICALLY

1. Voltage set too low on Thumbwheel Switch or programmed too low. Refer to Operating Data Tables I through V, pages 24 through 28. It may be necessary to increase these voltage settings slightly (+5 volts).

2. Inadequate ground connections. The Ground Terminal on the Voltage Divider and the Ground Stud at the rear of the THC-1 Control Module must both be connected directly to a Star Ground located on the Water Table (cutting bed). Grounding through the frame of the contouring machine is unreliable. It is also essential to prevent ground loops which can easily produce small voltages to which the THC-1 will respond. Direct connection of the above mentioned two points to the Star Ground is the only way to eliminate all possibility of ground loops.

3. R 12 Resistor or D1 Zener Diode burned out. (See photo: THC-1 Card Enclosure Detail, Figure 4, page 34. R 12 serves as a fuse to protect D1 (provides faster fuse action than an actual fuse). D1 is the signal input point from the Voltage Divider to the THC-1 Control Module. If R 12 is burned out, D1 may also be damaged. The most likely causes of R 12/D1 failure are reversed polarity connections at the Voltage Divider or incorrect wiring of the THC-1 Control Module Terminal Strip 1TB. A defective Voltage Divider may also cause failure of these components, but is unlikely.

4. Defective Voltage Divider. The Voltage Divider reduces the arc voltage by a ratio of 25:1. It may be checked by energizing the Plasma Power Supply and measuring the Divider output. At the power supply open circuit voltage of 400 VDC, the Divider Output should be approximately 16 VDC. This measurement may be made with a voltmeter connected between the Signal and Ground Terminals of the Voltage Divider. Use caution as the high frequency start pulse may destroy your meter if care is not used. Place the CONTROL Switch in MAN position and the ARC Switch in AUTO position. The Plasma TEST/RUN Switch should be in RUN position. Depress START and take the reading quickly before the High Frequency Generator is energized. The H.F. Generator comes on five seconds after you press START. Take your reading before it comes on and press STOP to protect the meter.

--- CAUTION ---

High Voltage is present on the white wire protruding from the Voltage Divider Case and in various parts of the plasma console including the large brass Cathode Block. Use care not to touch these components as fatal electric shock may result.

B. UP/DOWN LIGHTS FLASH, BUT TORCH DOES NOT MOVE UP OR DOWN

1. Torch lifter motor defective or incorrectly wired.

2. Relays 4 CRE or 5 CRE defective. These relays have a built-in LED indicator which lights when the relay is energized. This light does not indicate that the relay is actually closing. Check for relay closure using a voltmeter with a load connected to the relay.

REPLACEMENT OF DIGITAL AND ANALOG CIRCUIT BOARDS

The THC-1 Control Module is shipped with both Digital and Analog Boards installed. To change these boards, proceed as follows.

--- CAUTION ---

Circuit components on the boards are static sensitive. Avoid contact with the conductive areas and terminals on the boards. Always install conductive jumper bars across the board terminal connections if the boards are left out of the unit.

Spare jumper bars are provided on the inside of the circuit board access panel

1. Turn power OFF.

2. Remove access Cover Plate. (Two No. 8 thumbscrews)

3. Loosen retaining screw on circuit board enclosure.

4. Pull board enclosure straight out.

5. When inserting replacement board, be sure that you are inserting the correct board in the correct slot. See Figure 2, page 32. Also be certain board is oriented correctly (retaining screw at bottom).

   Viewed from the rear of the THC-1 Control Module, the Digital Board is on the Left, Analog Board on the Right.

   The board receptacles are keyed to accept only the correct board. Insertion of the incorrect board with excessive pressure will damage the receptacle.

6. After board is properly seated, tighten retaining screw, replace access cover and tighten two thumbscrews.

RETURN SHIPMENTS

In the event that it becomes necessary to return materials to Hypertherm, please follow the instructions below. Adherence to these instructions insures prompt and correct handling of your request and avoids loss of your material.

Do not return any material to Hypertherm without first obtaining a Return Goods Authorization Number (RGA #). No shipments are accepted without prior authorization. Contact your supplier to obtain an RGA # and shipping instructions.

To obtain a return authorization, the following information is required:

1. Stock Number
2. Serial Number - If component does not have a serial number, use the serial number of the unit from which it was removed.
3. Date of Delivery
4. Nature of damage or failure or other reason for return - BE SPECIFIC ABOUT DETAILS

REPACKAGING FOR RETURN SHIPMENTS

1. Before packing, attach a tag to the component showing the owner's name, service or repair required, serial number, and RGA #.

2. Do not ship circuit boards without first installing conductive jumper bars across the terminals. Spare jumper bars are attached to the rear access panel of the THC-1 Control Module. Avoid touching the conductive areas of the boards, as they are static sensitive.

3. Place boards in conductive shipping bags.

4. Pack all materials securely. Damage incurred in shipping due to improper packing is the customer's loss.

SECTION 8 OPERATING DATA TABLES

TABLE I

Operating Data for Mild Steel

Material Thickness Inches	mm	Nozzle and Swirl-ring Size Inches	Gas Type and Flowmeter Setting %	Injection Water Flow Setting %	Torch to Work Distance Inches	mm	Arc Voltage Setting Volts	Arc Current Setting Amperes	Travel Speed ipm	mm/min
.035	1				1/8	3	125	250	450	11430
.075	2	.120	N_2 30	85	1/8	3	130	250	300	7620
1/8	3				3/16	5	135	260	200	5080
1/4	6	Maximum current for this nozzle is 260 amp.			1/4	6	145	260	150	3810
1/8	3				1/4	6	140	300	200	5080
1/4	6	.166	N_2 45	75	1/4	6	145	350	150	3810
3/8	10				1/4	6	150	380	125	3175
1/2	13	Maximum current for this nozzle is 400 amp.			1/4	6	155	400	100	2540
1/2	13				3/8	10	160	500	115	2920
3/4	19	.187	N_2 45	75	3/8	10	165	500	75	1905
1	25				3/8	10	165	600	60	1525
1 1/4	32	Maximum current for this nozzle is 600 amp.			3/8	10	175	600	45	1145
1 1/4	32				1/2	13	185	700	50	1270
1 1/2	38	.220	N_2 **70**	100	1/2	13	195	700	40	1015
1 3/4	44				1/2	13	200	725	35	890
2	50	Maximum current for this nozzle is 750 amp.			1/2	13	205	725	30	760

Use the brass tapered retaining cap stock no. 020034 above 400 amperes.

To obtain optimum cut quality, plasma arc cutting nozzles are usually operated at an arc current slightly below the level that results in double-arcing. Attempting to operate nozzles above the maximum limit will cause a deterioration in performance.

The conditions listed above are chosen for optimum cut quality (not speed) and will generally produce excellent results. If deviations from these conditions are necessary, they should be limited to changes in arc current, arc voltage, and travel speed. These parameters have a significant effect on cut quality. Do not deviate from specified gas and water flows.

TABLE II

Operating Data for Stainless Steel

Material Thickness Inches	Material Thickness mm	Nozzle and Swirl-ring Size Inches	Gas Type and Flowmeter Setting %	Injection Water Flow Setting %	Torch to Work Distance Inches	Torch to Work Distance mm	Arc Voltage Setting Volts	Arc Current Setting Amperes	Travel Speed ipm	Travel Speed mm/min
.035	1	.120	N_2 30	85	1/8	3	125	250	450	11430
.075	2				1/8	3	130	250	300	7620
1/8	3				3/16	5	135	260	200	5080
1/4	6	Maximum current for this nozzle is 260 amp.			1/4	6	145	260	150	3810
1/8	3	.166	N_2 45	75	1/4	6	140	300	200	5080
1/4	6				1/4	6	145	350	150	3810
3/8	10				1/4	6	150	380	125	3175
1/2	13				1/4	6	155	400	100	2540
3/4	19	Maximum current for this nozzle is 400 amp.			5/16	8	160	400	50	1270
1	25				3/8	10	165	400	30	760
3/4	19	.187	N_2 45	75	3/8	10	165	500	75	1905
1	25				3/8	10	165	550	60	1525
1 1/2	38				3/8	10	170	580	30	760
2	50	Maximum current for this nozzle is 600 amp.			3/8	10	170	600	20	510
2	50	.220	N_2 70	100	1/2	13	190	700	25	635
3	75				5/8	16	200	750	12	305
		Maximum current for this nozzle is 750 amp.								

When cutting materials greater than 1½ inches (40mm) thick, lower the level of water in the water table to 3 inches (75mm) below the lower surface of the workpiece. Also de-energize the Water Muffler pump to improve arc penetration.

Use the brass tapered retaining cap stock no. 020034 above 400 amperes.

For cutting thicker plate refer to the chart "Operating Data for High Current Cutting."

TABLE III

Operating Data for Aluminum

Material Thickness Inches	Material Thickness mm	Nozzle and Swirl-ring Size Inches	Gas Type and Flowmeter Setting %	Injection Water Flow Setting %	Torch to Work Distance Inches	Torch to Work Distance mm	Arc Voltage Setting Volts	Arc Current Setting Amperes	Travel Speed ipm	Travel Speed mm/min
.035	1	.120	N_2 30	85	1/8	3	125	250	540	13715
.075	2				1/8	3	130	250	360	9145
1/8	3				3/16	5	135	260	240	6095
1/4	6	Maximum current for this nozzle is 260 amp.			1/4	6	145	260	180	4570
1/8	3	.166	N_2 45	75	1/4	6	140	300	240	6095
1/4	6				1/4	6	145	325	180	4570
3/8	10				1/4	6	150	350	150	3810
1/2	13				1/4	6	155	375	120	3050
3/4	19				5/16	8	160	400	60	1525
1	25	Maximum current for this nozzle is 400 amp.			3/8	10	165	400	35	915
1	25	.187	N_2 45	75	3/8	10	165	500	70	1830
1 1/2	38				3/8	10	170	550	35	915
2	50	Maximum current for this nozzle is 600 amp.			3/8	10	170	600	25	610
2	50	.220	N_2 70	100	1/2	13	190	700	30	760
3	75	Maximum current for this nozzle is 750 amp.			5/8	16	200	750	15	355

Use the brass tapered retaining cap stock no. 020034 above 400 amperes.

For cutting thicker plate refer to the chart "Operating Data for High Current Cutting."

TABLE IV

Sample Operating Data for Other Materials

Material Type	Thickness Inches	Thickness mm	Nozzle and Swirl-ring Size Inches	Gas Type & Flowmeter Setting %	Injection Water Flow Setting %	Torch To Work Distance Inches	Torch To Work Distance mm	Arc Voltage Setting Volts	Arc Current Setting Amperes	Travel Speed ipm	Travel Speed mm/min
Titanium	½	13	.166	N_2 45	75	¼	6	155	400	90	2285
Brass	½	13								70	1780
Copper	½	13								60	1525
Cast Iron	⅝	16								80	2030
Titanium	1	25	.187	N_2 45	75	⅜	10	165	550	50	1270
Copper/ Nickel-20%	1	25								45	1145

TABLE V

Operating Data for High Current Cutting

Material Thickness Inches	Material Thickness mm	Nozzle and Swirl-ring Size Inches	Gas Type and Flowmeter Setting %	Injection Water Flow Setting %	Torch to Work Distance Inches	Torch to Work Distance mm	Arc Voltage Setting Volts	Arc Current Setting Amperes	Travel Speed ipm	Travel Speed mm/min
			Stainless Steel							
3	75	.250	Premixed 65% Argon 35% Hydrogen 70	100	1	25	215	900	15	380
4	100	.250	Premixed 65% Argon 35% Hydrogen 70	100	1	25	225	1000	10	255
5	130	.250	Premixed 65% Argon 35% Hydrogen 80	100	1	25	235	1000	6	150
			Aluminum							
3	75	.250	70	100	1	25	210	900	18	460
4	100	.250	Premixed 65% Argon 35% Hydrogen 70	100	1	25	210	900	12	305
5	130	.250	Premixed 65% Argon 35% Hydrogen 70	100	1	25	210	1000	8	200
6	150	.250	Premixed 65% Argon 35% Hydrogen 70	100	1	25	210	1000	7	180

High Current Cutting is conventional cutting. It does not use the Water-Injection principle. The water sprayed from the nozzle is for nozzle cooling purposes only. It does not constrict the arc.

Always remove the Water-Muffler and lower the water level in the Water-Table when operating in the High Current Mode.

Use only the brass, tapered nozzle retaining cap — Stock No. 020-1-034.

WARNING: The plasma console is not vented for combustible gases. The optional ARGON/HYDROGEN MANIFOLD Stock Number 028-1-057 is required when using Argon/Hydrogen gas mixtures.

CAUTION: Never operate Water-Injection nozzles with Argon/Hydrogen gas mixtures.

Table VI
Nozzle Thickness Ranges and Limits

Nozzle Size	Nozzle Stock No.	Swirl-ring Size	Swirl-ring Stock No.	Thickness Range	Current Limit	Piercing Limit
**********		**********		(inches)	(amperes)	(inches)
.120	020050	.032	020039	.035 - 1/4	260	1/4
.166	020035	.032	020039	1/8 - 1	400	1
.187	020036	.032	020039	1/2 - 2	600	1-1/2
.220	020037	.052	020040	2 - 3	750	2
.250	020047	.062	020048	3 - 5	1000	Not Permitted

NOTE: The .250 Nozzle is for conventional cutting only. It must be used only with the Argon-Hydrogen Manifold.

SECTION 9 ILLUSTRATIONS AND SCHEMATICS

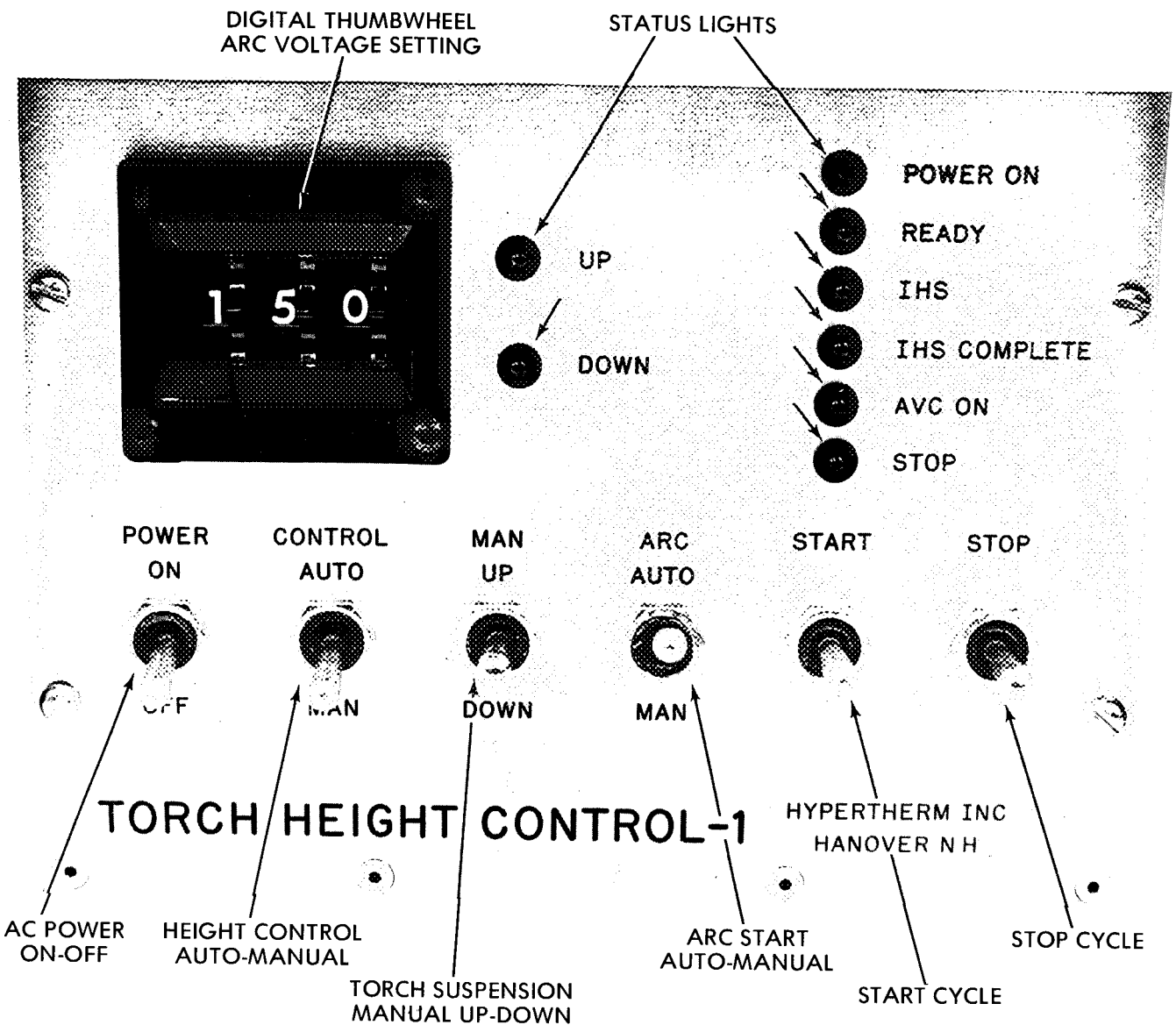


Figure 1.

FRONT PANEL

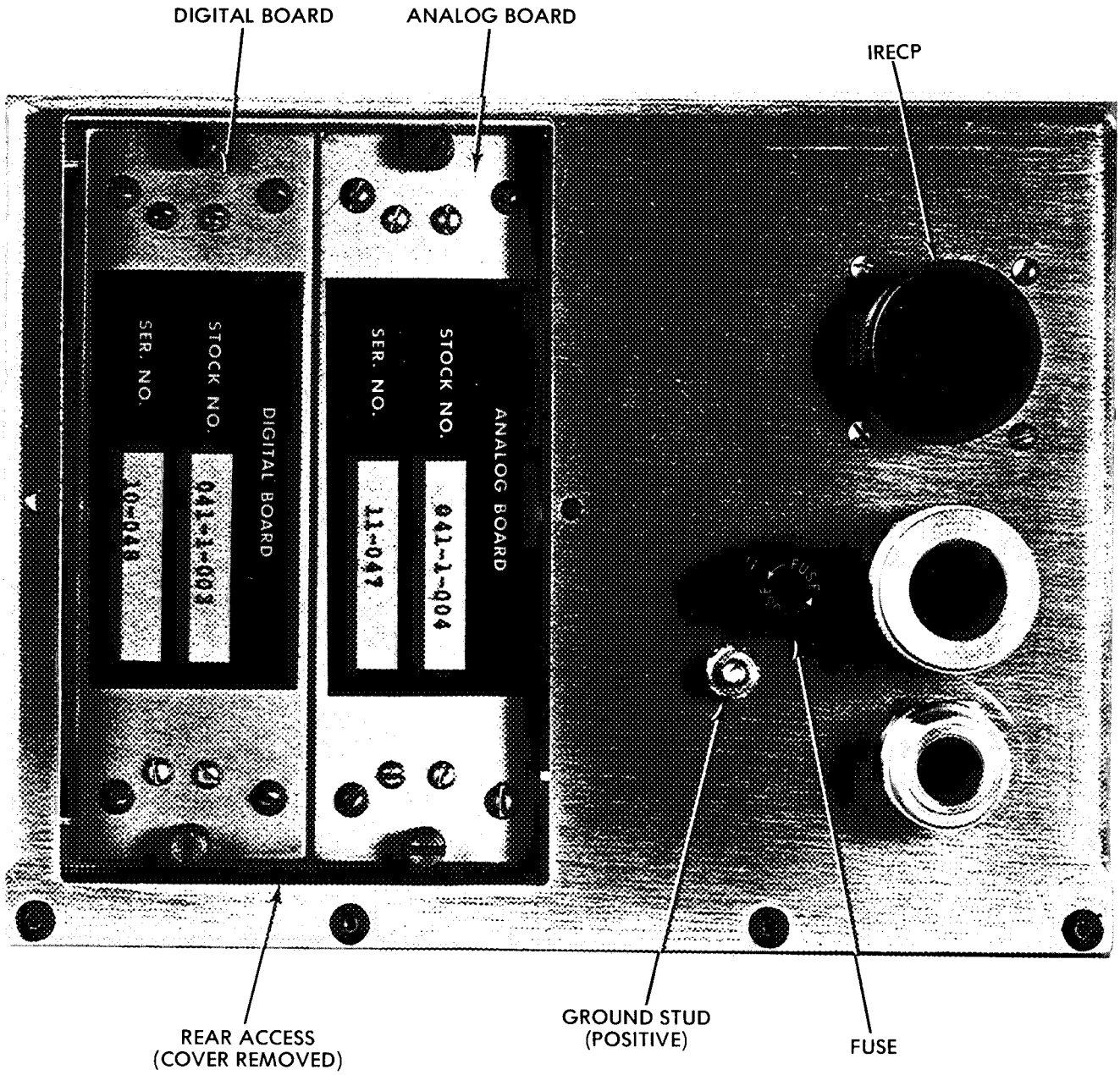


Figure 2.

THC-1
REAR PANEL

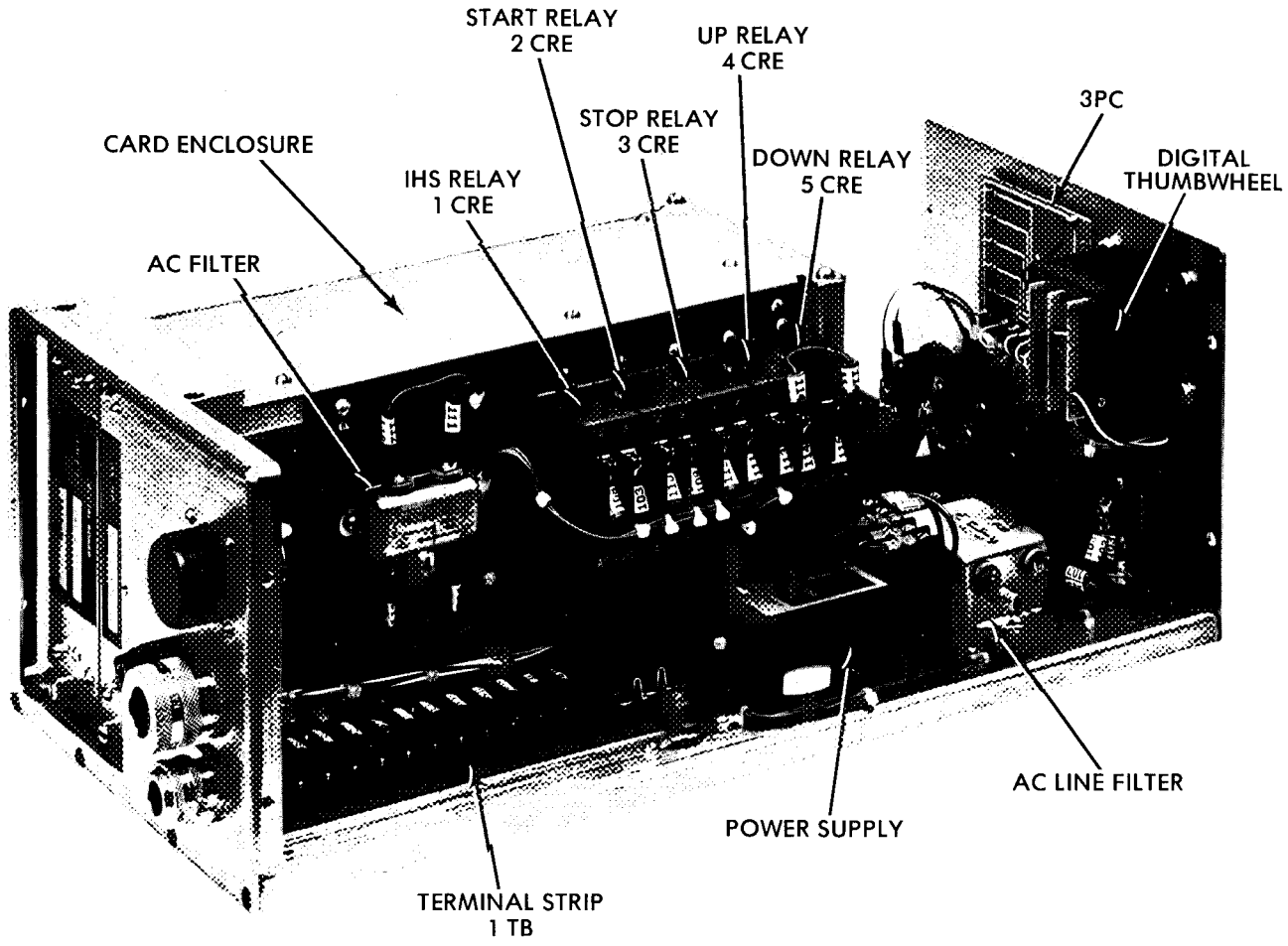


Figure 3.
THC-1
INTERIOR VIEW

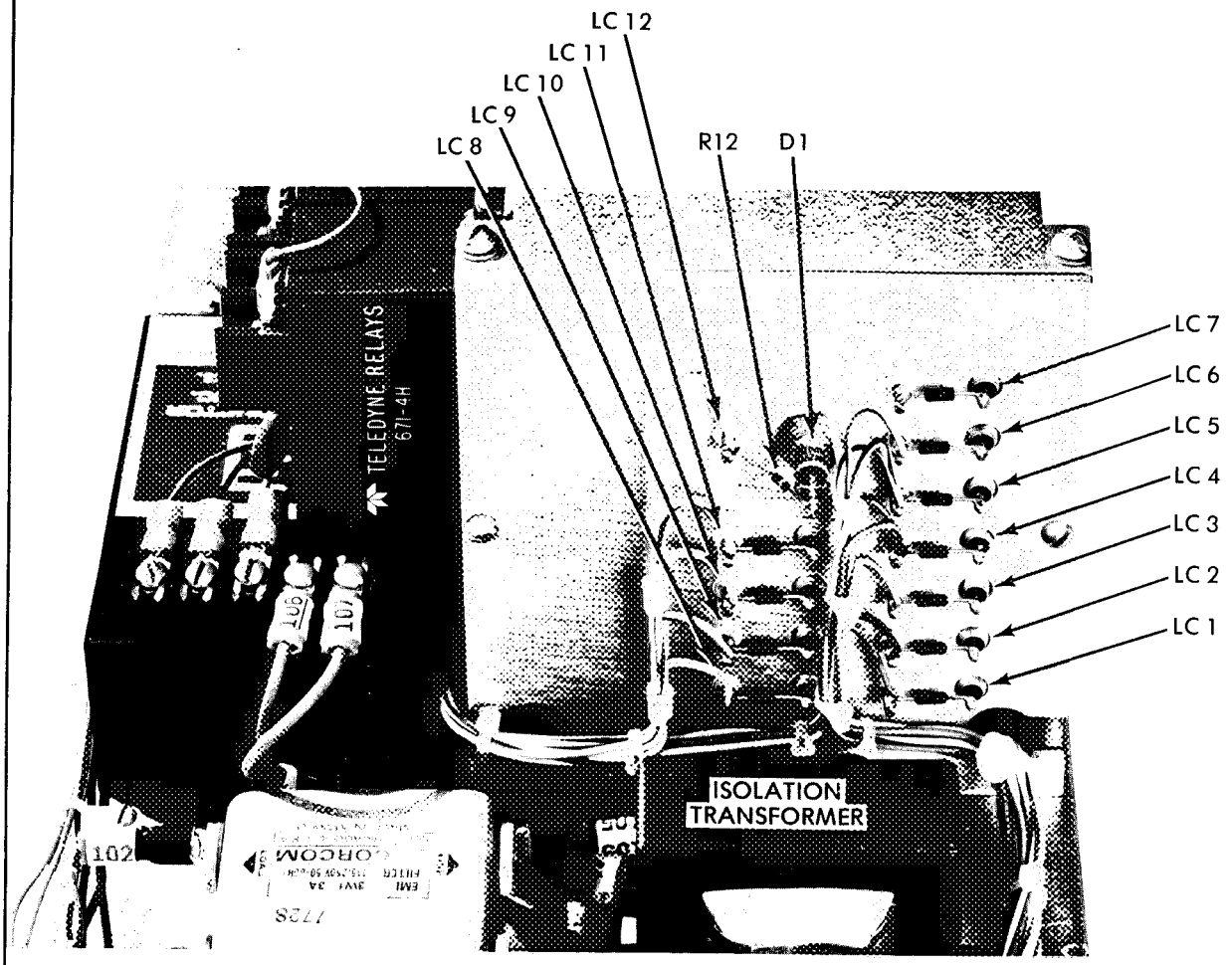
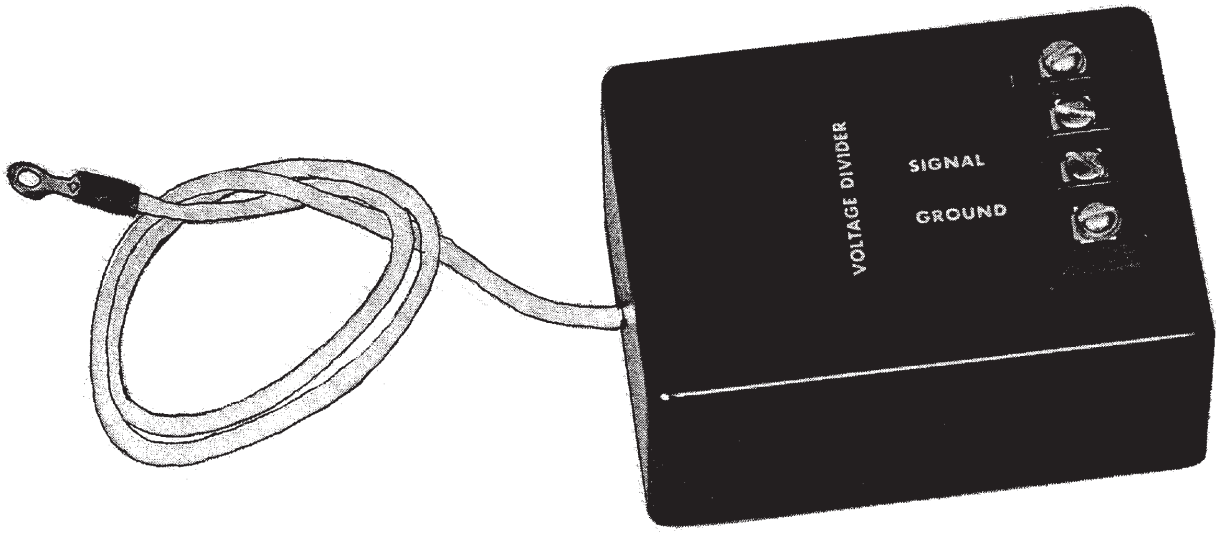


Figure 4.

THC-1
CARD ENCLOSURE DETAIL



25:1 VOLTAGE DIVIDER FOR TORCH HEIGHT CONTROL
Stock No. 041007

Figure 5

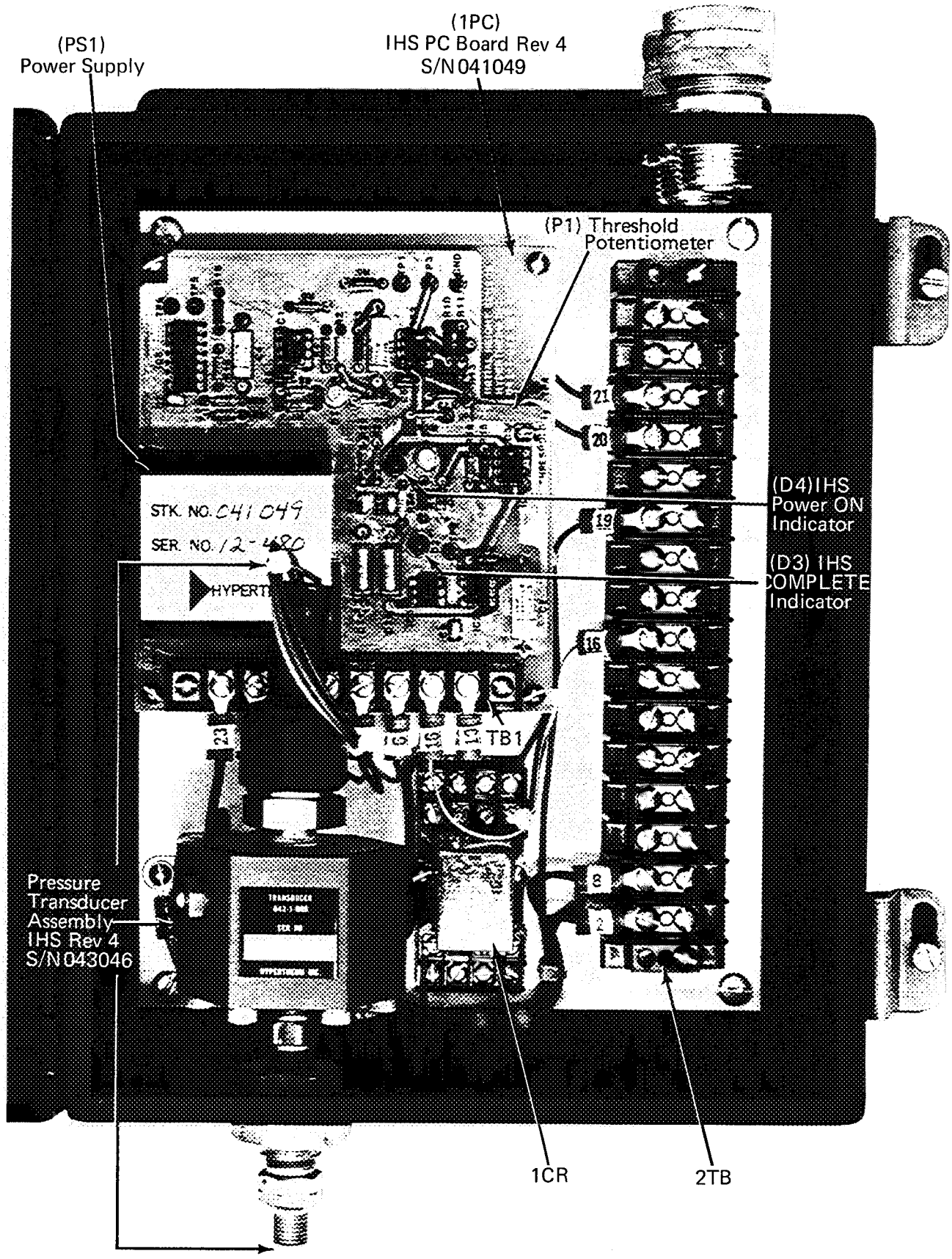


Figure 6

Fluidic Initial Height Sensor Module

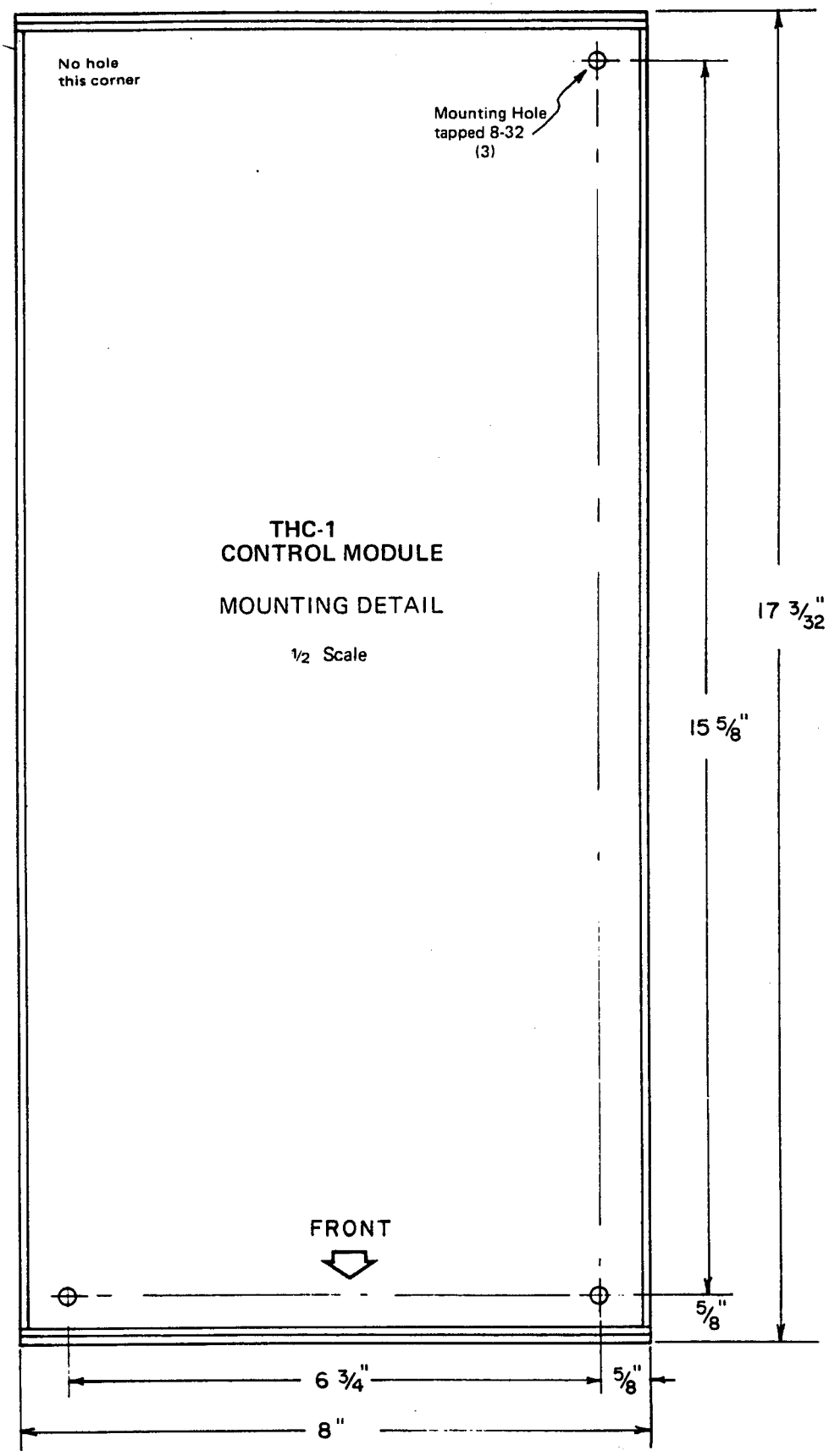

No hole
this corner
Mounting Hole
tapped 8-32
(3)
THC-1
CONTROL MODULE
MOUNTING DETAIL
1/2 Scale
17 3/32"
15 5/8"
FRONT
5/8"
6 3/4"
5/8"
8"

Figure 7

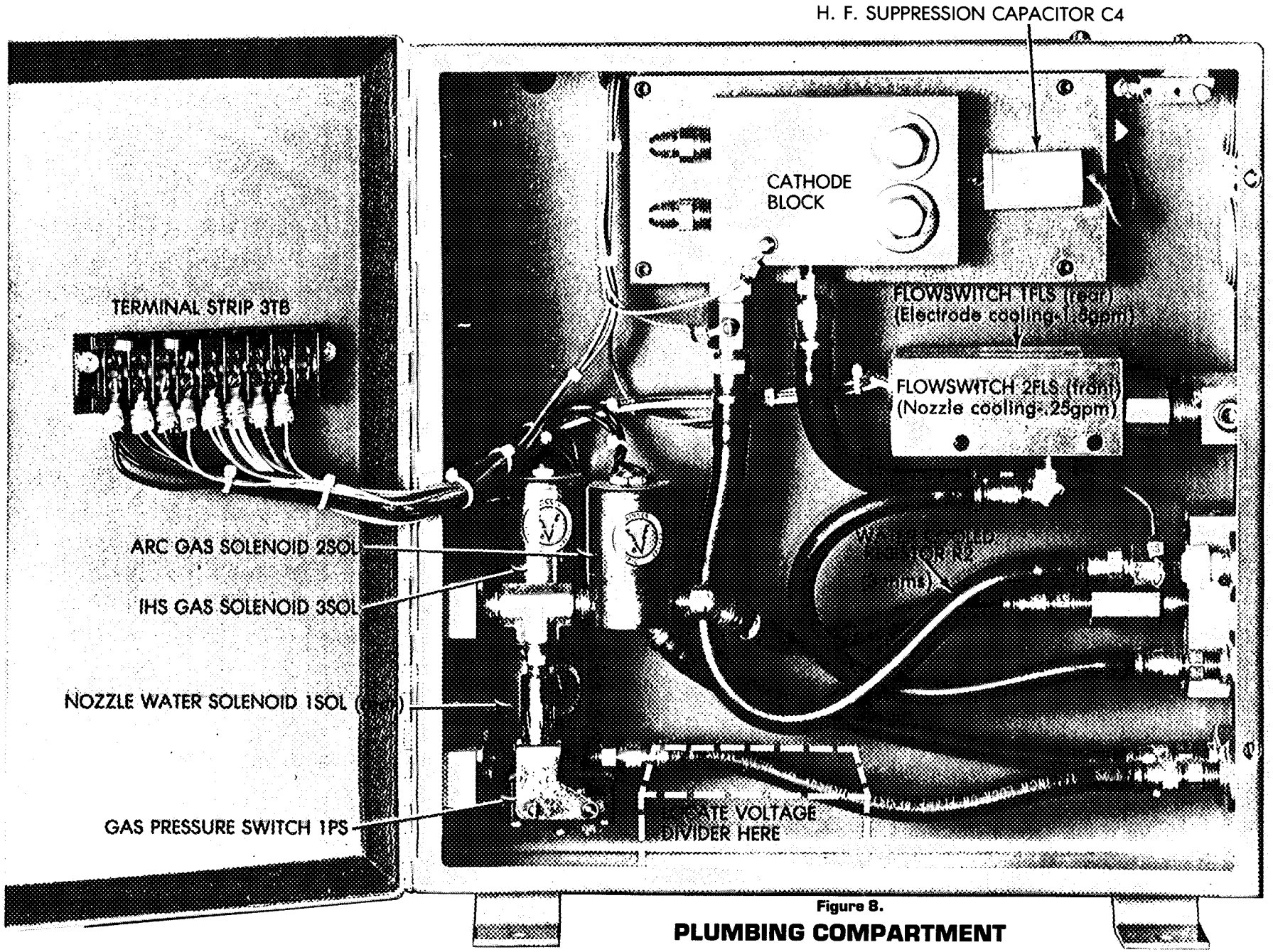


Figure 8.

PLUMBING COMPARTMENT

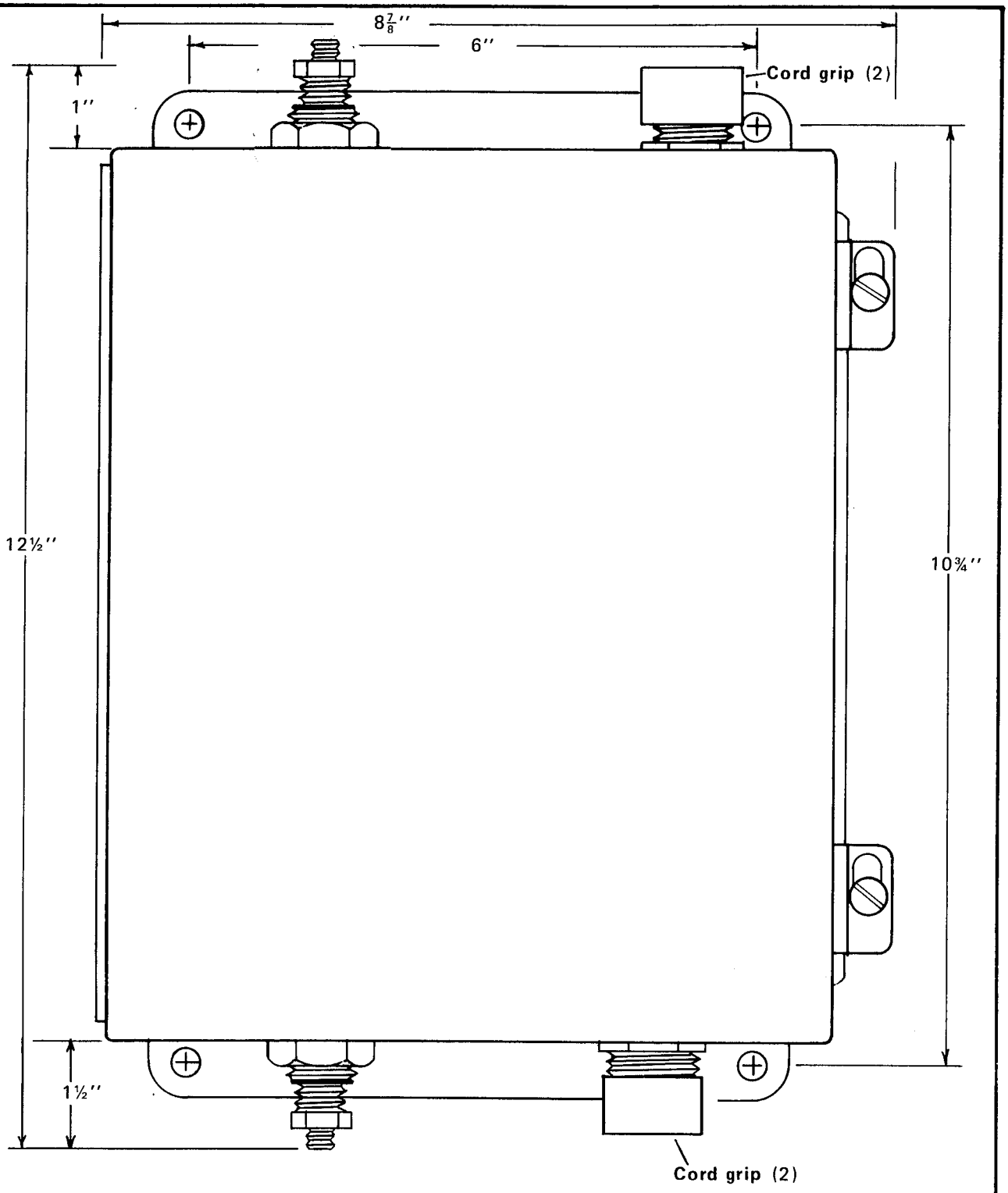
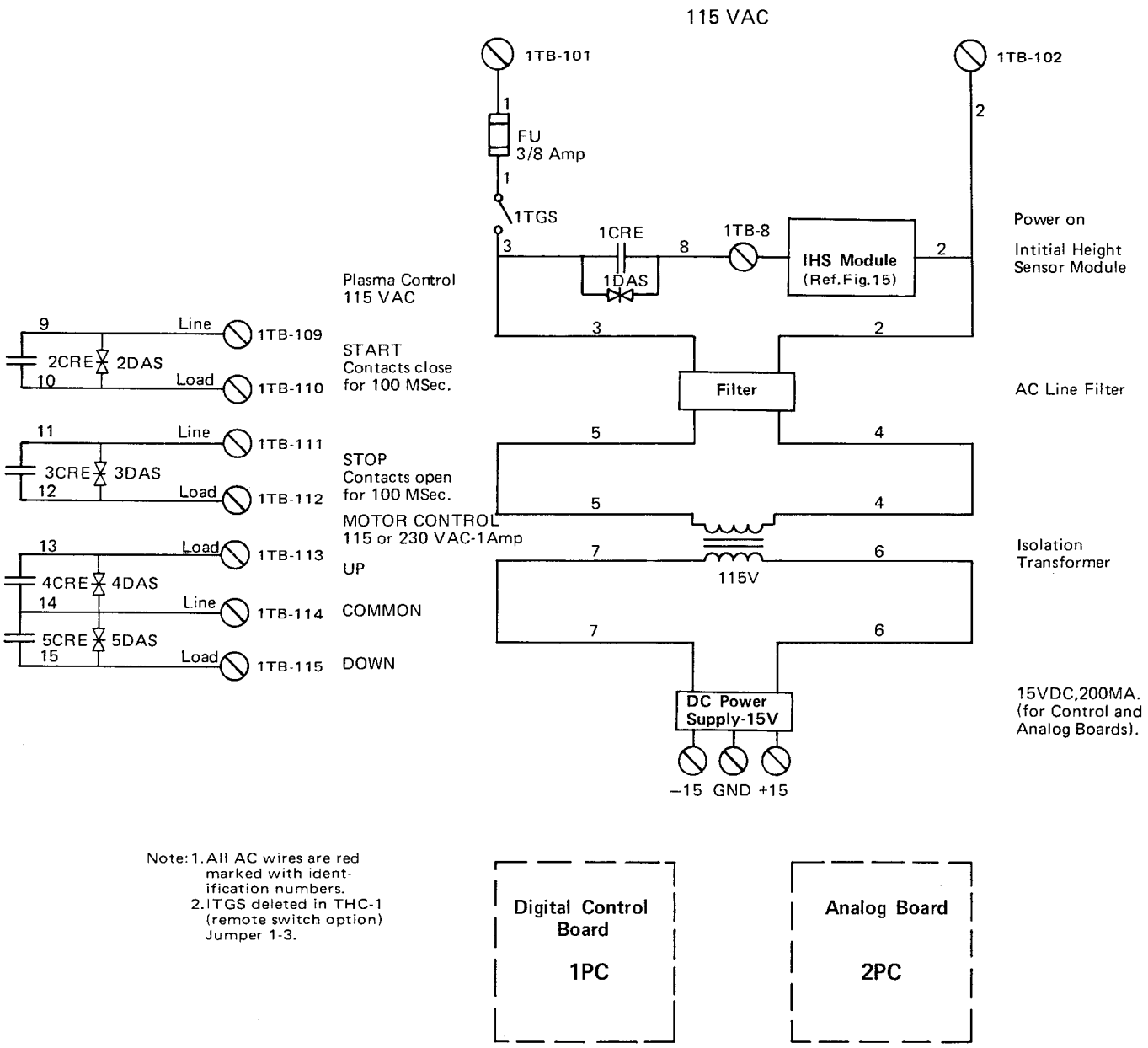


Figure 9

Fluidic Initial Height Sensor

Mounting Detail



Note: 1. All AC wires are red marked with identification numbers.
2. ITGS deleted in THC-1 (remote switch option) Jumper 1-3.

Figure 10. **THC-1 AC Electrical Schematic**

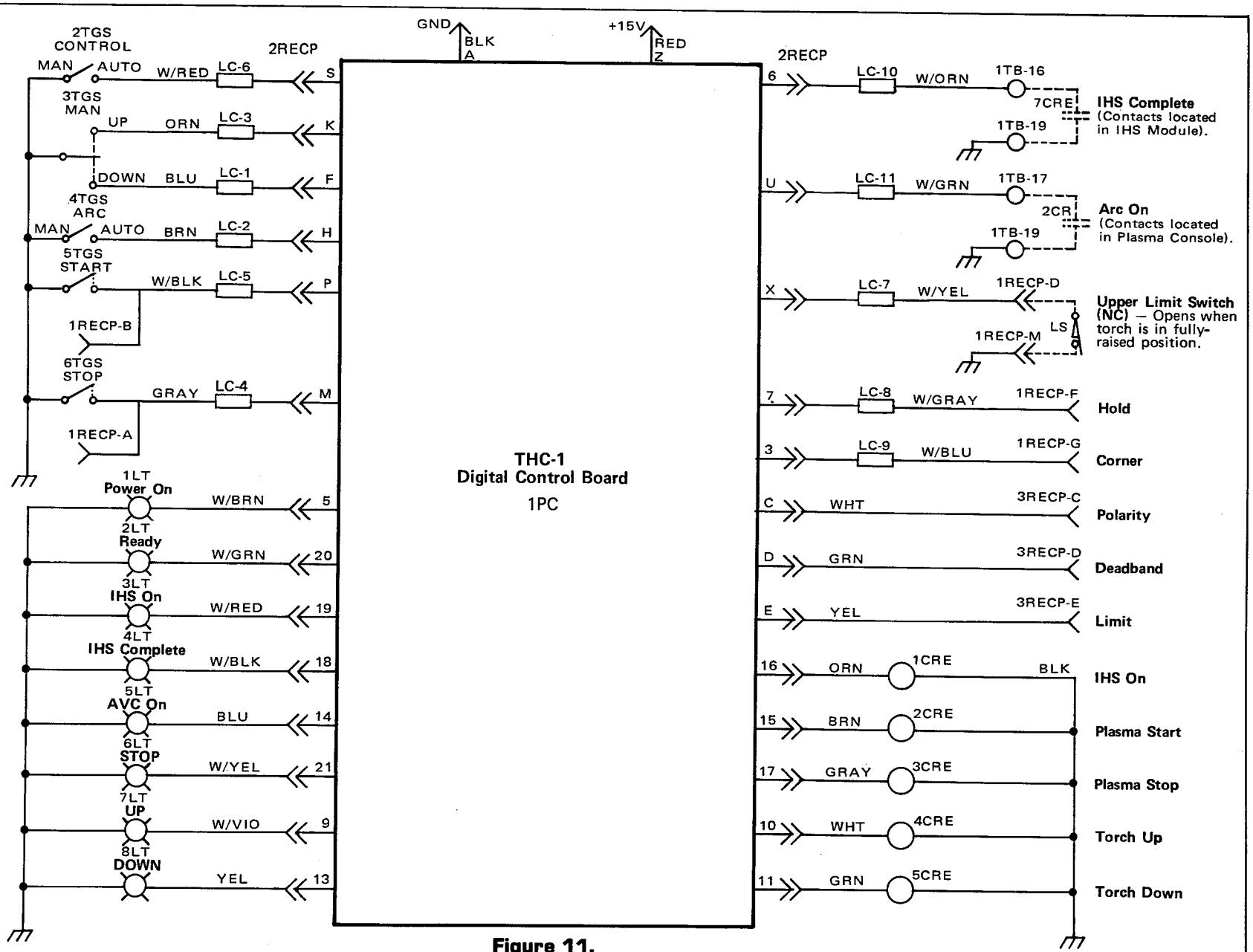


Figure 11.

THC-1 Digital Control Board Input/Output

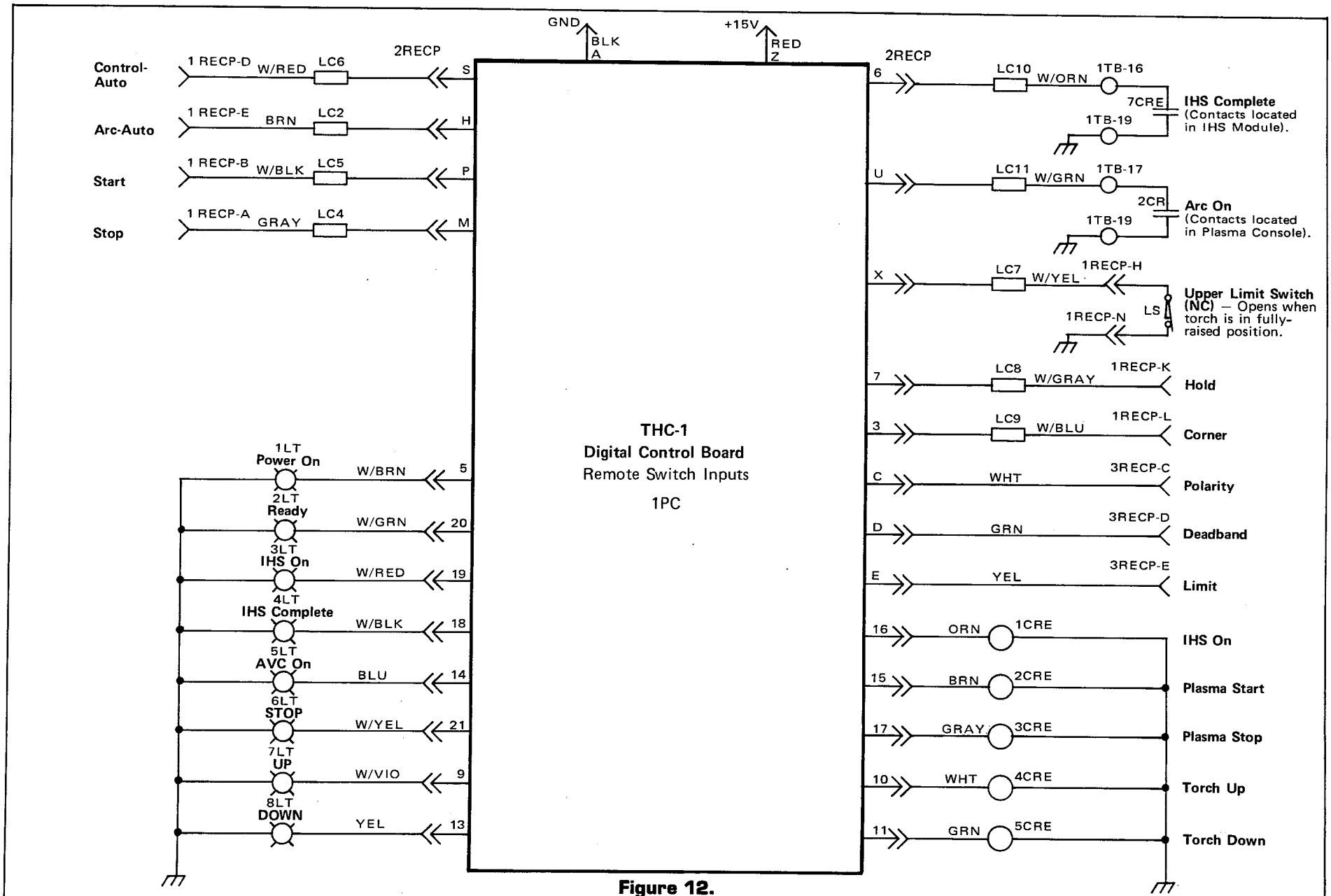


Figure 12.

THC-1 Digital Control Board — Remote Switch Input/Output

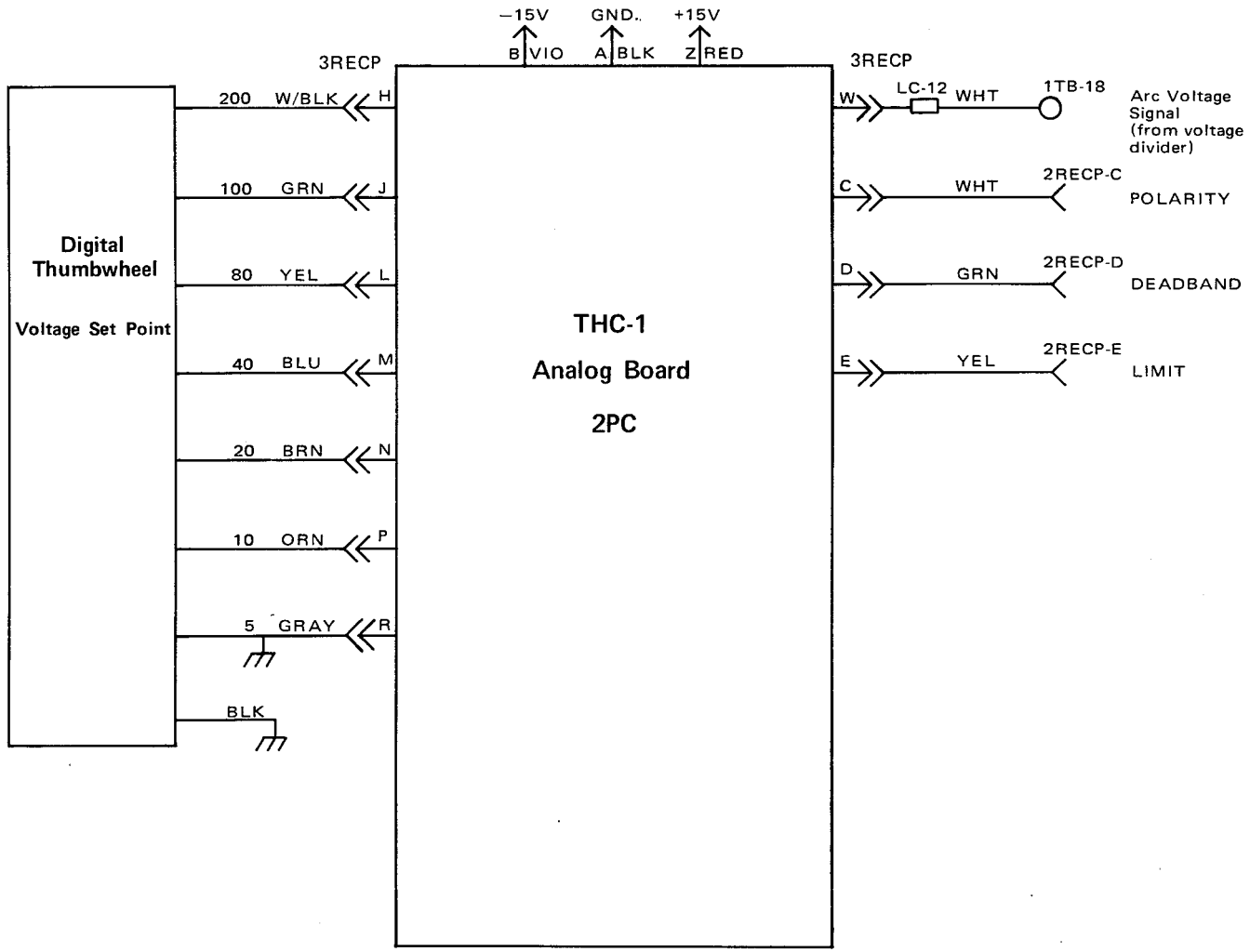


Figure 13. **THC-1 Analog Board — Input/Output**

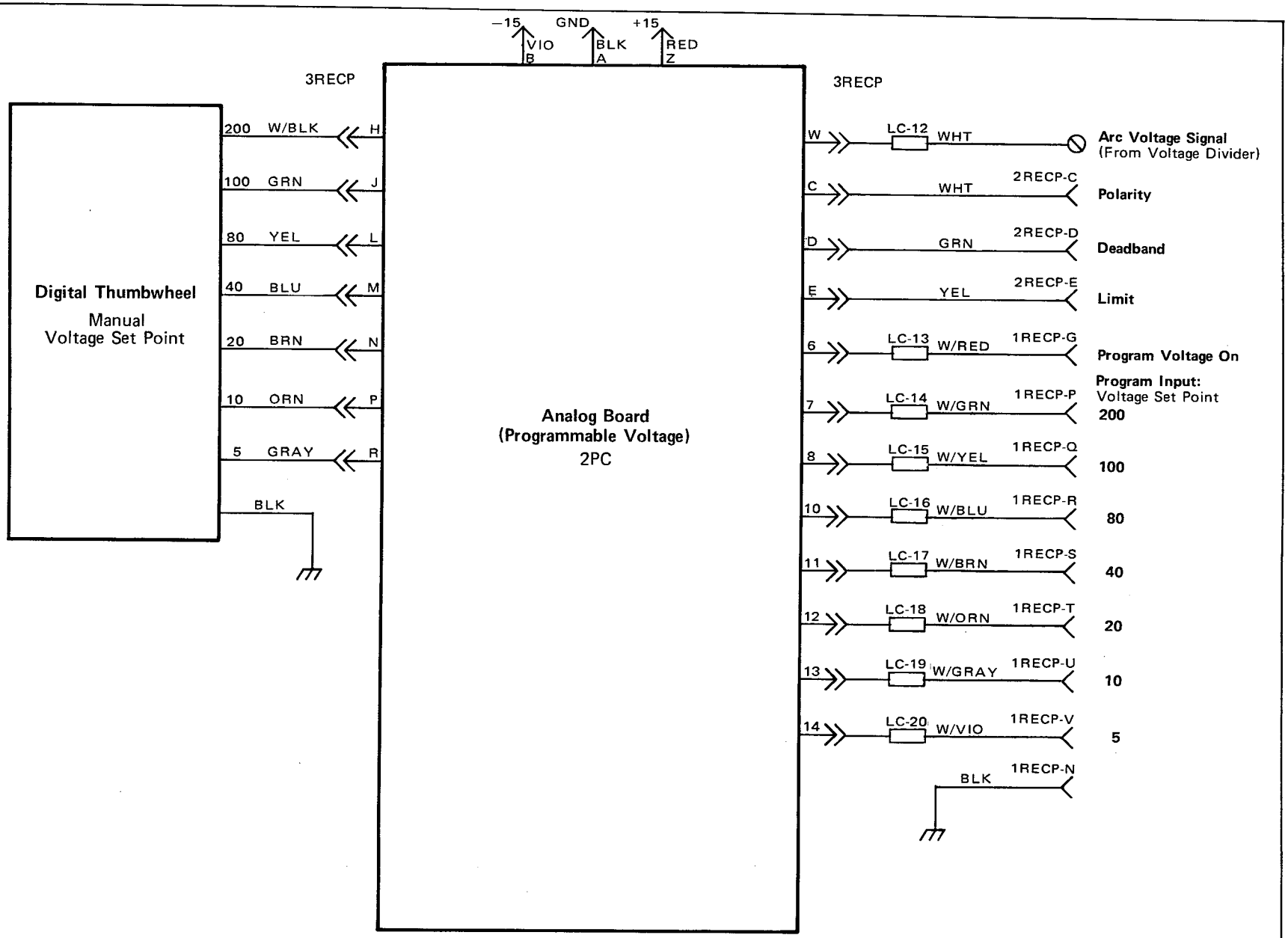
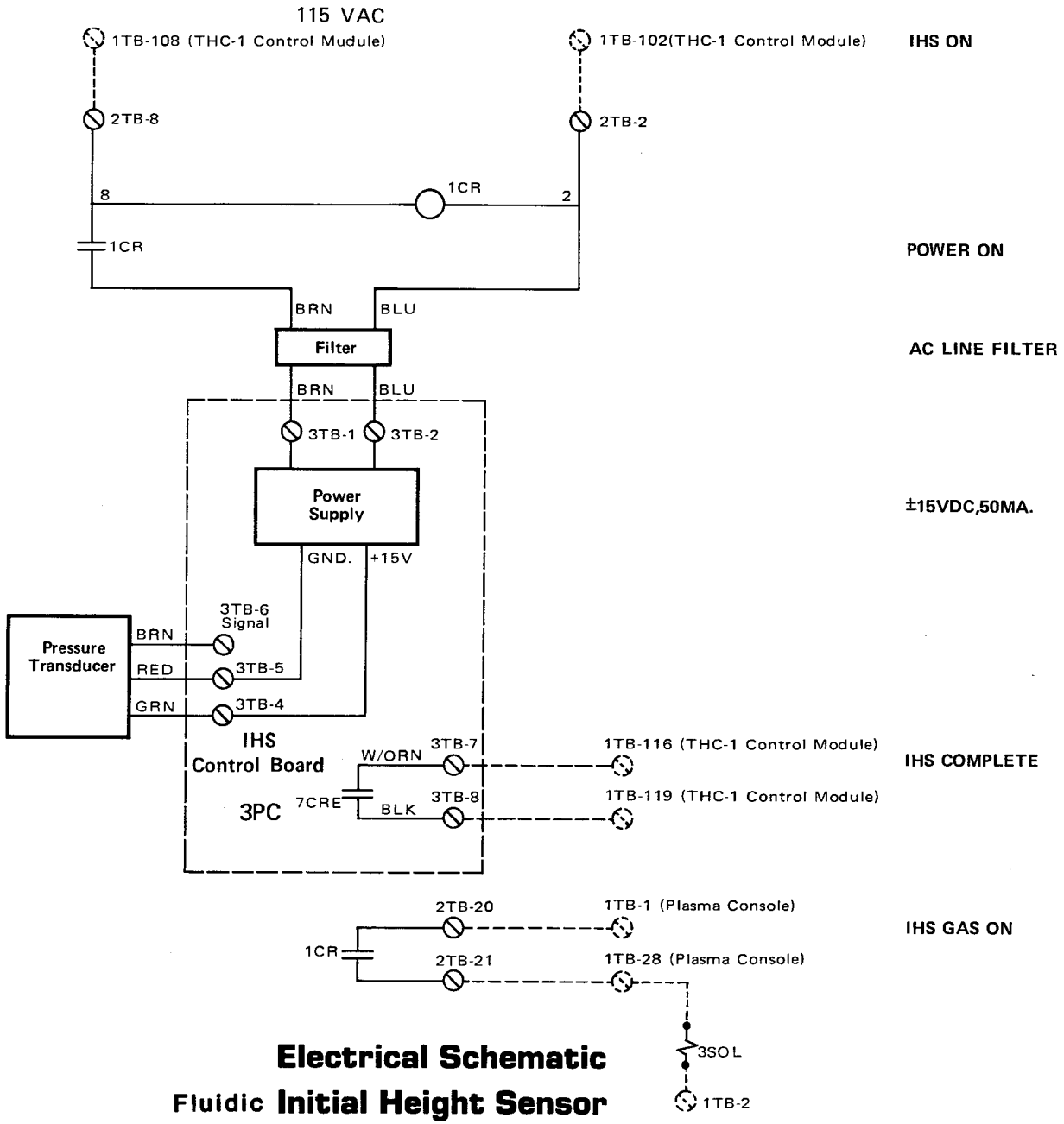


Figure 14.

THC-1 Analog Board — Programmable Voltage Input/Output



Electrical Schematic

Fluidic Initial Height Sensor

Figure 15.

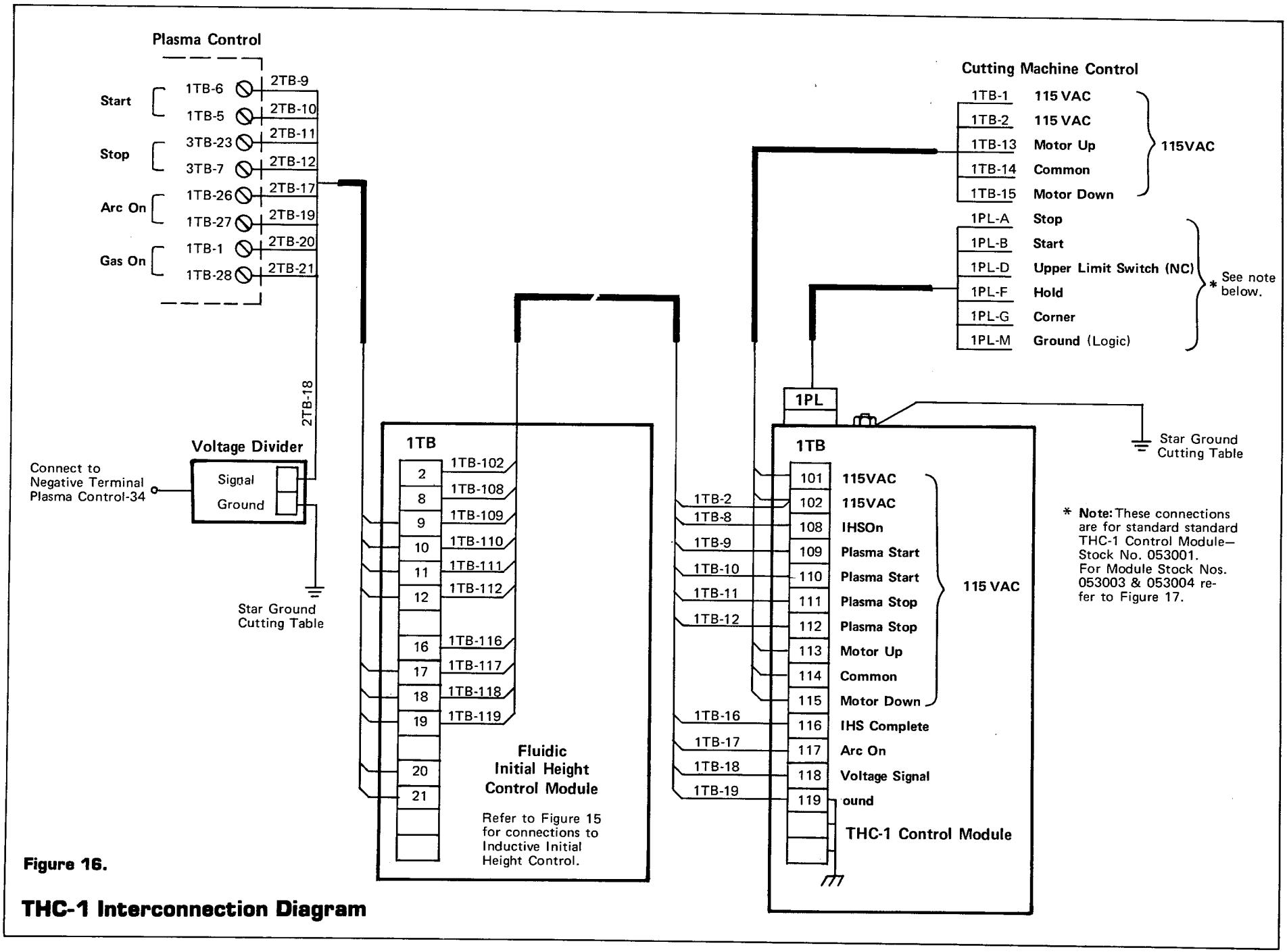


Figure 16.

THC-1 Interconnection Diagram

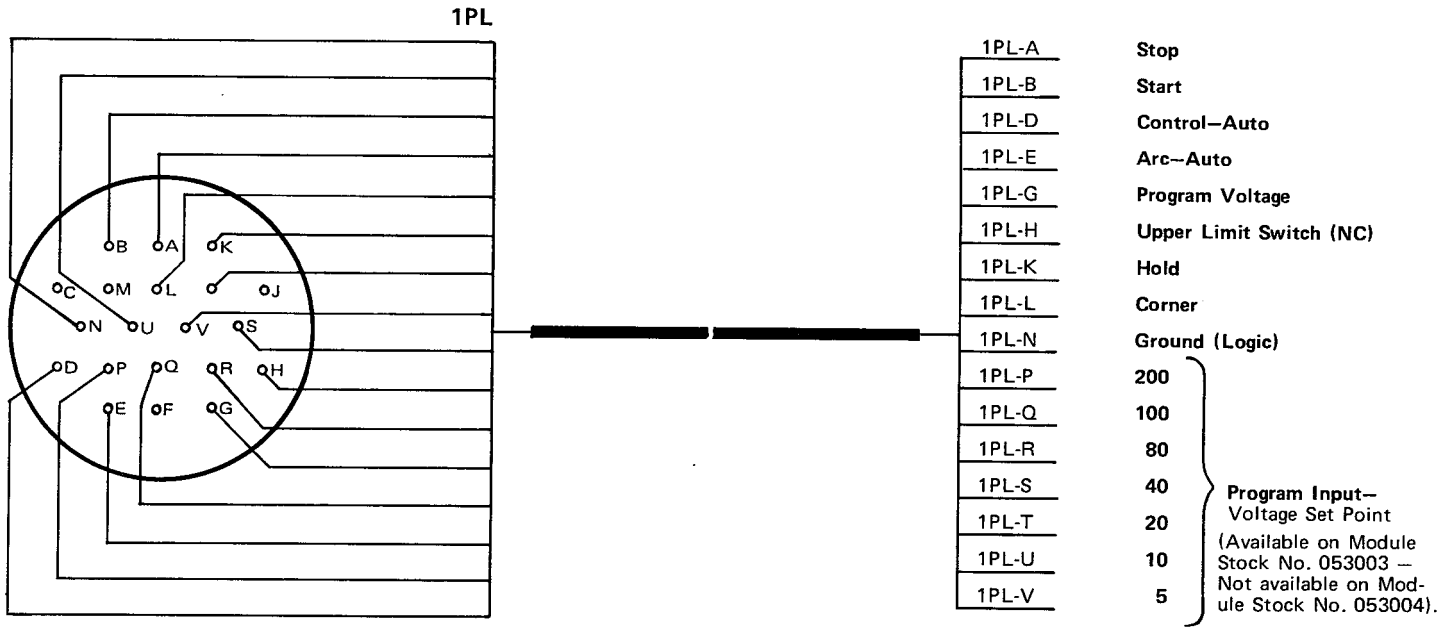
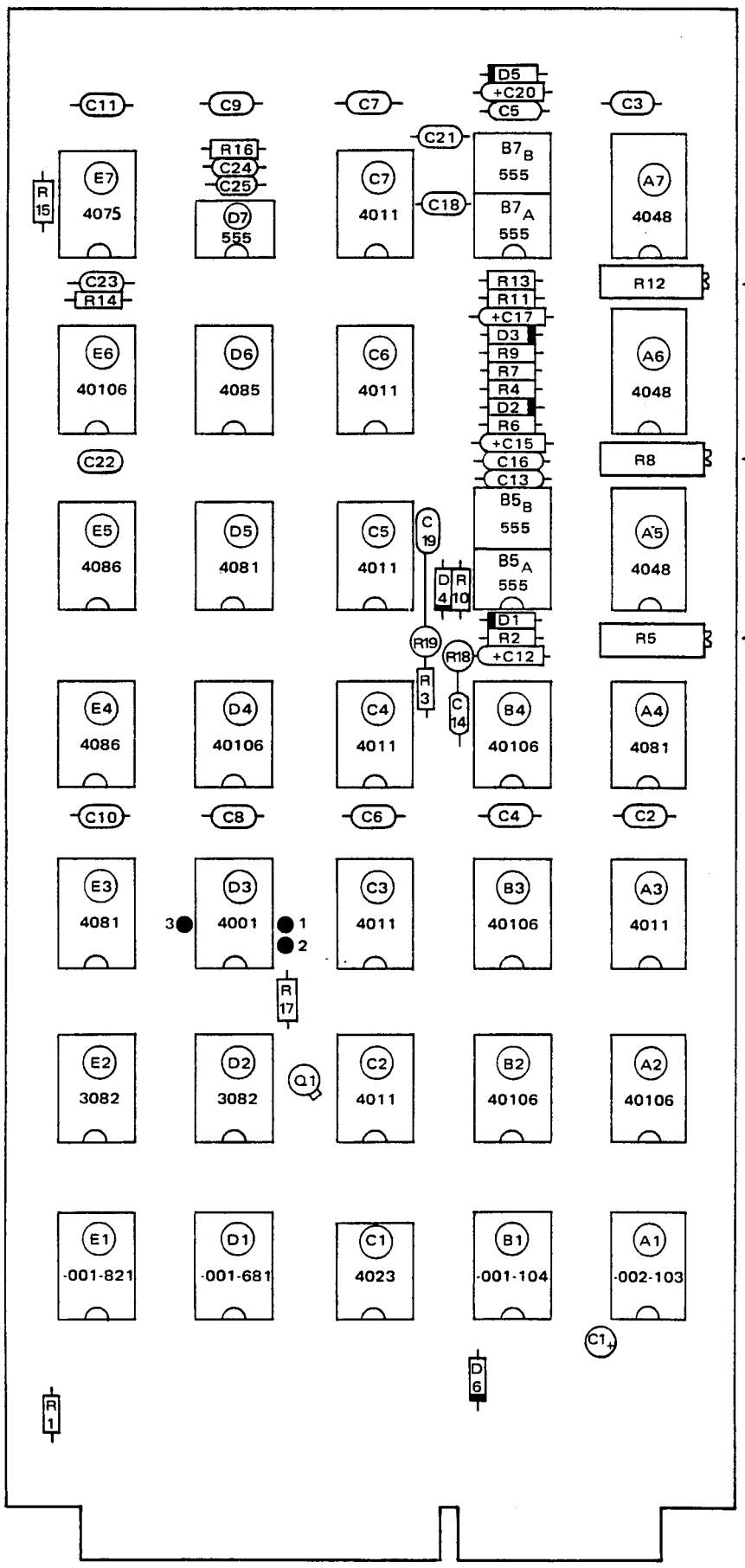


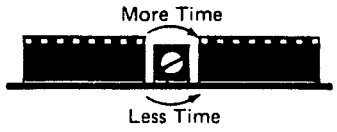
Figure 17.

Cable Assembly for Machine Interface using THC-1 Control Module Stock Nos. 053003 & 053004

HYPERTHERM,Inc.

THC-1 DIGITAL REV O COMPONENT LOCATOR





- 1. Test Point - IHS Delay
- 2. Test Point - IHS Up
- 3. Test Point - Arc on Delay

CONTACT ASSIGNMENT			
22	+15 Volts	+15 Volts	Z
21	Stop LED		Y
20	Ready LED	Upper Limit Switch N.O.	X
19	IHS LED		W
18	IHS Complete LED		V
17	Stop Relay	Arc N.O.	U
16	IHS ON Relay		T
15	Start Relay	Control Auto/ Man. N.O.	S
14	AVC LED		R
13	Down LED	Start N.O.	P
12			N
11	Down Relay	Stop N.O.	M
10	Up Relay		L
9	Up LED	Man. Up N.O.	K
8			J
7	Hold N.O.	Arc Start A/M N.O.	H
6	IHS Complete N.O.	Man. Down N.O.	F
5	Power ON LED	Limit	E
4		Dead Band	D
3	Corner N.O.	Polarity	C
2			B
1	GND.	GND.	A

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Figure 18

SECTION 10 REPLACEMENT PARTS LIST

PARTS LIST - CONTROL MODULE STOCK NO. 053001
PARTS LIST - CONTROL MODULE STOCK NO. 053003
PARTS LIST - CONTROL MODULE STOCK NO. 053004
PARTS LIST - FLUIDIC IHS MODULE STOCK NO. 053013
PARTS LIST - MISCELLANEOUS RELATED PARTS

PARTS LIST STOCK NO. 053001 CONTROL MODULE, THC-1 (Standard)

ITEM NO.	QUANTITY	IDENT	STOCK NO.	DESCRIPTION
1	1		001027	COVER, CONTROL MODULE THC
2	1		001032	COVER, REAR ACCESS THC-1
3	2		008072	THUMBSCREW
4	1	AC FILTER	009040	FILTER, AC, 3 AMP 3W1
5	1	TRAN	014003	TRANSFMR ISO 15VA 115 IN/OUT
6	1		029034	WIRING HARNESS SA, THC-1 ST
7	1	CARD ENCLOSURE	029041	PC CARD CAGE SA, THC-1 ST
8	1	1PC	041003	PC BD ASSY DIGITAL THC-1
9	1	2PC	041005	PC BD ASSY ANALOG THC-1
10	1		041011	POWER SOURCE, THC-1/THC-2

SELECTED REPLACEMENT PARTS INCLUDED IN ASSEMBLIES LISTED ABOVE

ITEM NO.	QUANTITY	IDENT	STOCK NO.	DESCRIPTION
1	1	TWS	005052	SWITCH, THUMBWHEEL EEC
2	1	MAN UP/DWN	005042	SWITCH,TOG 1PL MOM ON/OFF/ON
3	2	START,STOP	005043	SWITCH,TOG 1PL MOM --/ON/ON
4	3	POWER,CONTROL,ARC	005044	SWITCH,TOG 1PL MAINT ON/ON
5	5(sets)		003046	BRACKET, RELAY MTG
* 6	1	1RECP	008067	RECEPTACLE, 14 PIN F
7	2	2,3 RECP	008065	SOCKET, PC BOARD
8	1		008068	FUSE HOLDER,DCM,PCC,THC1&2
9	1	FU	008069	FUSE, 3/8A-SB,313,375
10	10		008113	TERMINAL, RELAY (Gold Pins)
11	8	LT	009306	DIODE, SIL, LED, RED
12	1	D1	009034	DIODE, ZENER 15V
13	13	LC	009035	FILTER, ERIE
14	1	R12	009484	RESISTOR, 390 OHM, $\frac{1}{4}$W, 5%
15	2	4,5 DAS	009038	VARISTOR, MOV, 250V
16	3	1,2,3, DAS	009039	VARISTOR, MOV, 175V
** 17	5	1,2,3,4,5 CRE	003044	RELAY,I/O CONVERTER AC 673-6H (Red body)

* Mating plug for this receptacle is S/N 008086 PLUG, 14 PIN M (MS 3106B 20-27P)

** When a DC Torch Lifter Motor is used, 4 CRE and 5 CRE should be replaced with Stock No. 003045 RELAY, I/O CONVERTER DC 673-22 (Blue body)

PARTS LIST STOCK NO. 053003 CONTROL MODULE, THC-1 (Prog.Volt-Rem.Sw).

ITEM NO.	QUANTITY	IDENT	STOCK NO.	DESCRIPTION
1	1		001027	COVER, CONTROL MODULE THC
2	1		001032	COVER, REAR ACCESS THC-1
3	2		008072	THUMBSCREW
4	1	AC FILTER	009040	FILTER, AC, 3 AMP 3W1
5	1	TRAN	014003	TRANSFMR ISO 15VA 115 IN/OUT
6	1		029035	WIRING HARNESS SA,THC-1 PV/RS
7	1	CARD ENCLOSURE	029042	PC CARD CAGE SA, THC-1 PV/RS
8	1	1PC	041003	PC BD ASSY DIGITAL THC-1
9	1	2PC	041005	PC BD ASSY ANALOG THC-1
10	1		041011	POWER SOURCE, THC-1/THC-2

SELECTED REPLACEMENT PARTS INCLUDED IN ASSEMBLIES LISTED ABOVE

ITEM NO.	QUANTITY	IDENT	STOCK NO.	DESCRIPTION
1	1	TWS	005052	SWITCH, THUMBWHEEL EEC
2	5(sets)		003046	BRACKET, RELAY MTG
* 3	1	1RECP	008032	RECEPTACLE, 20 PIN F
4	2	2,3 RECP	008065	SOCKET, PC BOARD
5	1		008068	FUSE HOLDER,DCM,PCC,THC1&2
6	1	FU	008069	FUSE, 3/8A-SB,313,375
7	10		008113	TERMINAL, RELAY (Gold Pins)
8	8	LT	009306	DIODE, SIL, LED, RED
9	1	D1	009034	DIODE, ZENER 15V
10	13	LC	009035	FILTER, ERIE
11	1	R12	009484	RESISTOR, 390 OHM, ¼W, 5%
12	2	4,5 DAS	009038	VARISTOR, MOV, 250V
13	3	1,2,3, DAS	009039	VARISTOR, MOV, 175V
** 14	5	1,2,3,4,5 CRE	003044	RELAY,I/O CONVERTER AC 673-6H (Red body)

* Mating plug for this receptacle is S/N 008086 PLUG, 14 PIN M (MS 3106B 20-27P)

** When a DC Torch Lifter Motor is used, 4 CRE and 5 CRE should be replaced with Stock No. 003045 RELAY, I/O CONVERTER DC 673-22 (Blue body)

PARTS LIST STOCK NO. 053004 CONTROL MODULE, THC-1 (Remote Switch)

ITEM NO.	QUANTITY	IDENT	STOCK NO.	DESCRIPTION
1	1		001027	COVER, CONTROL MODULE THC
2	1		001032	COVER, REAR ACCESS THC-1
3	2		008072	THUMBSCREW
4	1	AC FILTER	009040	FILTER, AC, 3 AMP 3W1
5	1	TRAN	014003	TRANSFMR ISO 15VA 115 IN/OUT
6	1		029036	WIRING HARNESS SA, THC-1 RS
7	1	CARD ENCLOSURE	029025	PC CARD CAGE SA, THC-1 RS/RVC
8	1	1PC	041003	PC BD ASSY DIGITAL THC-1
9	1	2PC	041005	PC BD ASSY ANALOG THC-1
10	1		041011	POWER SOURCE, THC-1/THC-2

SELECTED REPLACEMENT PARTS INCLUDED IN ASSEMBLIES LISTED ABOVE

ITEM NO.	QUANTITY	IDENT	STOCK NO.	DESCRIPTION
1	1	TWS	005052	SWITCH, THUMBWHEEL EEC
2	5(sets)		003046	BRACKET, RELAY MTG
* 3	1	1RECP	008032	RECEPTACLE, 20 PIN F
4	2	2,3 RECP	008065	SOCKET, PC BOARD
5	1		008068	FUSE HOLDER,DCM,PCC,THC1&2
6	1	FU	008069	FUSE, 3/8A-SB,313,375
7	10		008113	TERMINAL, RELAY (Gold Pins)
8	8	LT	009306	DIODE, SIL, LED, RED
9	1	D1	009034	DIODE, ZENER 15V
10	13	LC	009035	FILTER, ERIE
11	1	R12	009484	RESISTOR, 390 OHM, ¼W, 5%
12	2	4,5 DAS	009038	VARISTOR, MOV, 250V
13	3	1,2,3, DAS	009039	VARISTOR, MOV, 175V
** 14	5	1,2,3,4,5 CRE	003044	RELAY,I/O CONVERTER AC 673-6H (Red body)

* Mating plug for this receptacle is S/N 008086 PLUG, 14 PIN M (MS 3106B 20-27P)

** When a DC Torch Lifter Motor is used, 4 CRE and 5 CRE should be replaced with Stock No. 003045 RELAY, I/O CONVERTER DC 673-22 (Blue body)

PARTS LIST STOCK NO. 053013 FLUIDIC IHS MODULE

ITEM NO.	QUANTITY	IDENT	STOCK NO.	DESCRIPTION
1	1		002047	ENCL., CONTROL MODULE IHS
2	1		002048	PANEL, IHS
3	1	1CR	003034	RELAY, 120VAC 4PDT MINI
4	1		003035	SOCKET, RELAY, MINI
5	2		008071	STRAIN RELIEF, $\frac{1}{2}$ x.375 -.500
6	1	2TB	008073	TERMINAL STRIP (16)
7	1		009041	FILTER, AC, 1 AMP 1B3
8	1		024088	HOSE ASSY, IHS HI PRESS, 2.5'
9	1		029046	TEE SA, IHS MOD/169 CONS
10	1	1PC	041049	PC BD ASSY IHS-REV 4
11	1		043006	TRANSDUCER ASSY IHS REV 4

ITEM NO.	QUANTITY	IDENT	STOCK NO.	DESCRIPTION
1	1		041007	VOLTAGE DIVIDER,THC-1/THC-2
2	1		041009	EXTENDER,PC BD,ANALOG,THC-1
3	1		041010	EXTENDER,PC BD,DIGITAL,THC-1

Items 2 and 3 are optional. Item 1 is supplied with each THC-1 package.

APPENDIX
INSTALLATION OF UNDERWATER CUTTING OPTION

APPENDIX INSTALLATION OF UNDERWATER CUTTING OPTION

DESCRIPTION: The Underwater Cutting Option consists of an Inductive IHS Module, Stock No. 053012, and an Inductive Probe Assembly, Stock No. 029044. It may be used to automatically set pierce height both above and under water.

An air cylinder, which is part of the probe assembly, extends two inductive probes downward to a point approximately even with the end of the torch. The torch then moves downward until the probes detect the presence of the workpiece. Downward motion is stopped at this point and the air cylinder automatically retracts the probes to keep them away from the cutting arc. The actual pierce height of the torch is determined by its position in the torch bracket.

PREINSTALLATION REQUIREMENTS: The Inductive IHS package requires a source of shop air regulated to 20 psig.(1.4 bar) for operation of the air cylinder. This source is to be connected to the Inductive IHS Module.

INSTALLATION: The IHS Module is should be located near the plasma console. Attach the Probe Assembly to the torch station with the torch mounting bracket which is included in this assembly.

Insert the torch into the torch bracket. Do not clamp the torch by the stainless steel body, it must be clamped only by the fiberglass sleeve. Initially, the torch should be clamped as high as possible in the bracket without making contact between the metal torch body and the bracket. A final adjustment will be made later.

Wiring may be completed by refering to the diagram on page A2. A seven conductor cable is required between the IHS Module and the Plasma Console. A ten conductor cable is needed between the IHS Module and the THC-1 Control Module. Belden Type 8778FR cable may be as used for this application.

Two cables fitted with three-pin male connecting plugs are attached to the Inductive Probes. Matching female plugs are provided and should be wired to the IHS Module according to the diagram on page A2 and then connected to the male plugs.

The 20 psig. air supply is connected to the fitting on the IHS Module marked INLET. A user supplied hose should be connected from the air cylinder to the IHS Module Fitting marked OUTLET.

FINAL ADJUSTMENT: After all connections have been made, place the plasma TEST/RUN Switch in TEST position, THC-1 CONTROL Switch in AUTO position, and ARC Switch in MAN position. Cycle the system to the IHS Complete state by depressing the THC-1 START Switch. When the torch stops above the workpiece, loosen the torch bracket and adjust the torch to the desired pierce height. This height is normally about 3/8 inch (10mm). A higher setting is desirable if plate over one inch is to be cut frequently. Retighten the torch clamp and depress the STOP switch to return the system to the READY State.

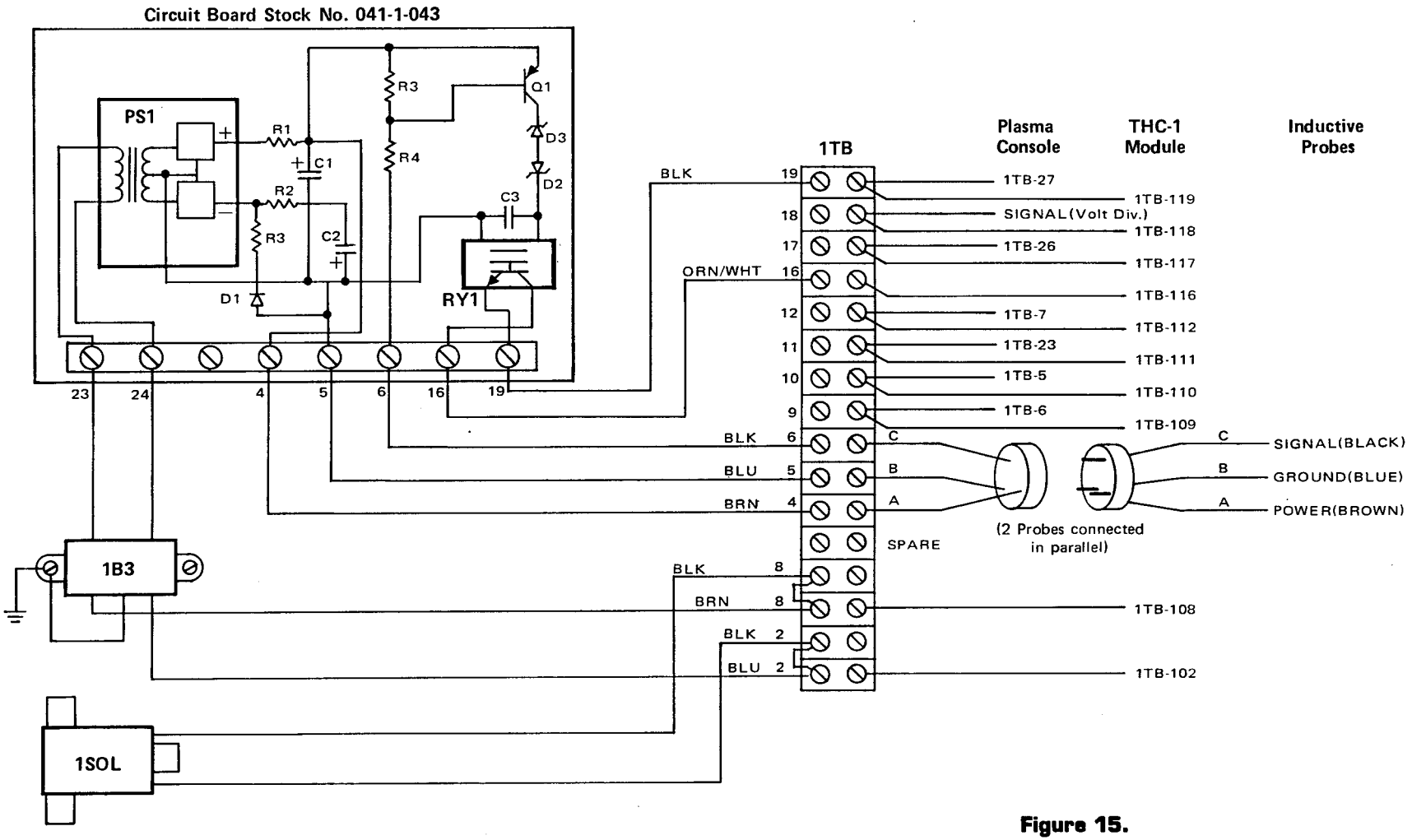
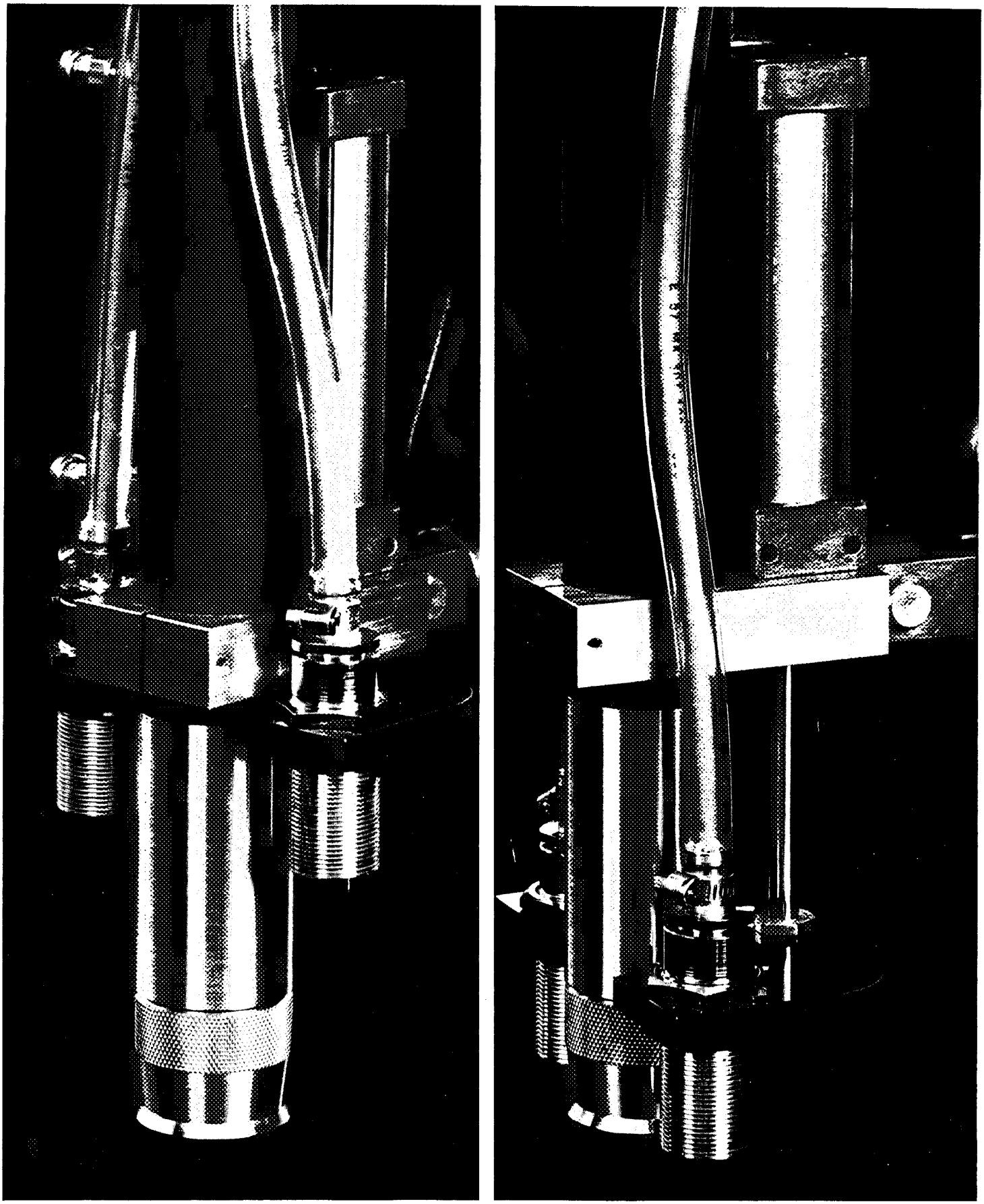


Figure 15.

Interconnection Schematic Inductive Initial Height Sensor for Underwater Cutting



Probes Retracted **Probes Extended**

FIGURE 20 **Inductive Probe Assembly for Underwater Cutting**

PARTS LIST STOCK NO. 053012 INDUCTIVE IHS MODULE

ITEM NO.	QUANTITY	SYMBOL	STOCK NO.	DESCRIPTION
1	1		002095	ENCL., CONTROL MODULE UW-IHS
2	1		002096	PANEL, UW-IHS
3	1		006021	VALVE, SOL 75 PSI ¼ NPTF
4	2		008070	STRAIN RELIEF, ½ x .312-.375
5	2		008071	STRAIN RELIEF, ½ x .375-.500
6	1		008073	TERMINAL STRIP (16)
7	2		008095	JUMPER, TERMINAL
8	1	FIL	009041	FILTER, AC, 1 AMP 1B3
9	2		015001	ADAPTER, BULKHEAD, ¼ NPTF
10	4		015005	ADAPTER, ¼ NPT x #4
11	2		015006	SWIVEL, #4
12	1		015100	ADAPTER, ¼ NPT x #4 POLY
13	1		015502	NIPPLE, ¼ x CLOSE
14	1		024038	HOSE ASSY, #4 x 7"
15	1		041043	PC BD ASSY UW-IHS

PARTS LIST STOCK NO. 029044 INDUCTIVE PROBE ASSEMBLY

ITEM NO.	QUANTITY	SYMBOL	STOCK NO.	DESCRIPTION
1	1		004082	BRACKET, IND SENSOR, UW-IHS
2	1		004083	BRACKET, TORCH MTG, UW-IHS
3	2		004085	NUT, INSULATING, IND SENSOR
4	2		005074	SENSOR, INDUCTIVE UW-IHS
5	2		008144	PLUG, 3 PIN F
6	2		008145	PLUG, 3 PIN M
7	1		015005	ADAPTER, $\frac{1}{4}$ NPT x #4
8	1		027024	CYLINDER, AIR, IND SENSOR
9	6ft (1.8m)		046023	TUBING, 3/8" (9.5mm) ID TYGON